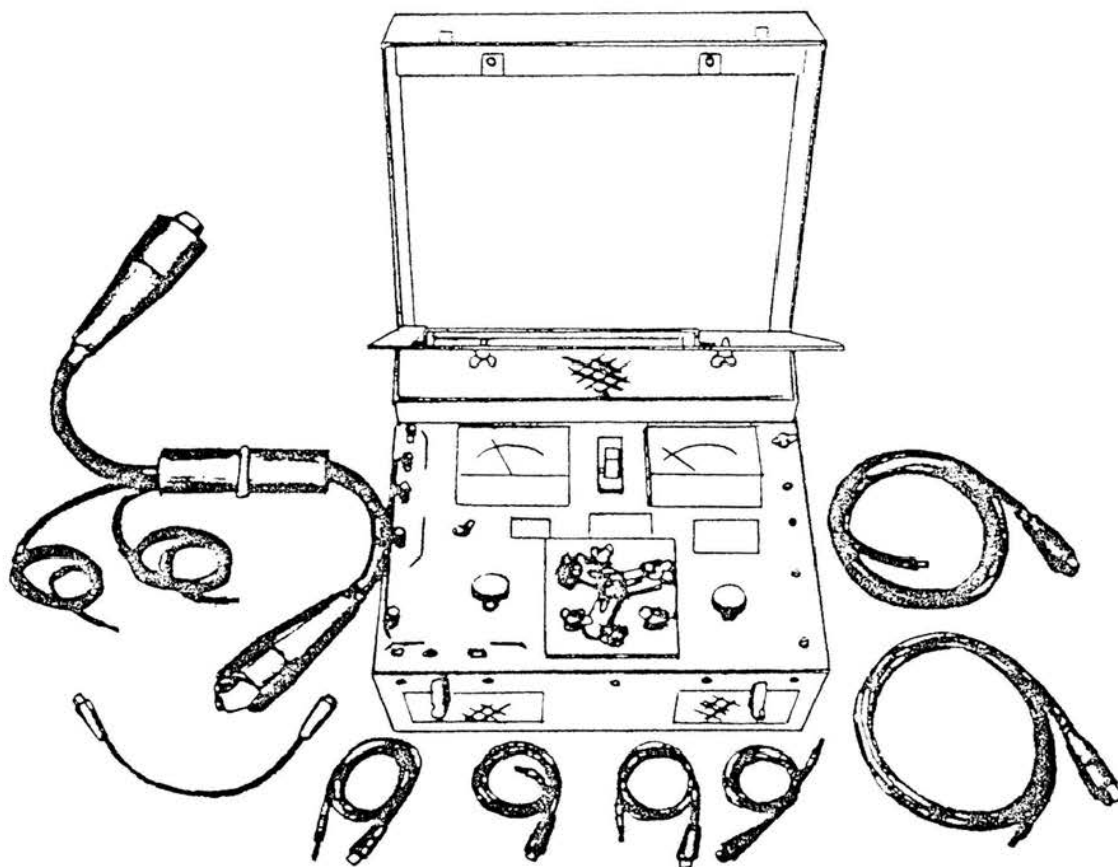


**AUTOMOTIVE LOW VOLTAGE
CIRCUIT TEST SET
MODEL LVR-3E**

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AUTOMOTIVE LOW VOLTAGE
CIRCUIT TEST SET
MODEL LVR-3E

FIGURE 1

SECTION I

INTRODUCTION & DESCRIPTION

- 1-1 INTRODUCTION: This handbook describes an Automotive Low Voltage Circuit Tester National Stock Number 4910-00-092-9136 manufactured by the Sun Electric Corporation, Crystal Lake, Illinois, 60014 and is designated as a Sun Model LVR-3E.

The manual contains Operating Instructions, Vehicle Testing, Trouble shooting, Repair, Parts Listing and all pertinent data relating the LVR-3E Tester.

- 1-2 PURPOSE & FUNCTION: The model LVR-3E is a non-powered self contained tester used for testing D.C. generators, starters, voltage regulators and other components associated with the electrical systems of automotive-type gasoline engines. Test leads provided with the tester enable the connecting of the tester to the engine electrical systems.

Instrument and controls of the tester are internally connected to separate binding posts on the tester instrument panel.

- 1-3 CAPABILITIES & DESCRIPTION

- 1-3-1 DESCRIPTION: The LVR-3E tester is a portable hand carried tester consisting of a two piece steel case. The lower case encloses the control panel and the removable upper case cover contains a storage compartment with the test leads and manual.

The instrument panel assembly is fully contained and is easily removed from the lower case for inspection or repair. All the electrical instruments, controls, and binding posts are located on the top of the control panel and are identified for operation and values. A cooling fan/motor assembly is located on the underside of the control panel.

A panel containing wire wound resistive elements is attached to the rear end of the instrument panel and is located in the cooling air stream duct behind the control panel.

Removal of the control panel from the lower case enables viewing of a circuit diagram with component values and part numbers and is located on the inside surface of the case bottom.

The lower case contains inlet cooling air openings on the operator's side and bottom which must be unobstructed when the tester is in use.

A load link bar assembly located on the instrument panel enables variable voltages and amperage ranges to be selected for testing.

The voltage and amperage zones are identified accordingly, and are mechanically positioned and secured. Test leads have red and black tip plugs and test clips.

1-3-2

CAPABILITIES: Four voltmeter ranges permit readings from 0.02 volt to 50 volts direct current, and four current ranges permit readings from 0.1 ampere to 500 amperes D.C.. A variable resistance load circuit is used to check generator output and to provide an electrical range from 5 to 100 amperes on 12 or 24 volt systems. The three lower reading current scales of the ammeter have shunts inside the tester. The high reading (500 ampere) scale requires the use of the external shunt-provided. Generator output is manually controlled with a field rheostat when testing at fixed engine speeds.

TABLE I

D.C. AMMETER & D.C. VOLTMETER RANGES

D.C. AMMETER	D.C. VOLTMETER
-3 to 0 to 10	0 to 1
-15 to 0 to 50	0 to 10
-30 to 0 to 100	0 to 20
-150 to 0 to 500	0 to 50

1-4

PERFORMANCE CHARACTERISTICS: The tester is capable of performance as stated in paragraph 1-3-2 for a duty cycle of ten (10) minutes on and ten (10) minutes off. With the test set in a horizontal position in an ambient air temperature of +80 F (+/-5 F) the overall initial accuracy is within seven (7) percent of full scale value for the 500 ampere ammeter circuit and three (3) percent full scale value for the internal shunt ammeter circuit. The voltmeter circuit accuracy is +/-2% of full scale value. The overall reliability in accuracy is within one (1) percent of the full scale value from the initial accuracy readings for both the ammeter and voltmeter circuits.

The tester is capable of the following momentary overloads.

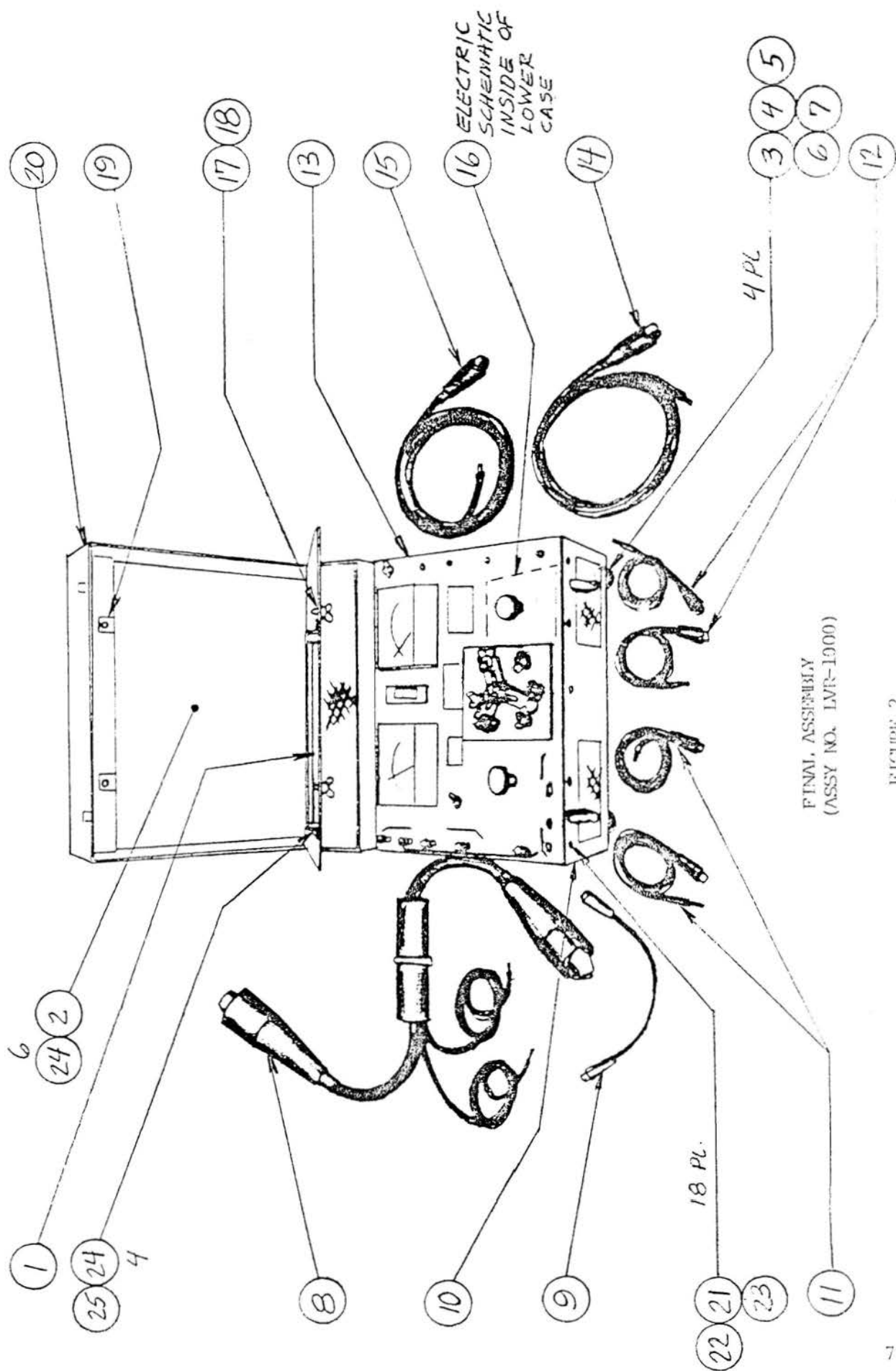
- 1-4-1 The ammeter circuit is capable of withstanding a momentary overload of five (5) times end scale value for one (1) second ON and sixty (60) seconds OFF.
- 1-4-2 The voltmeter circuit is capable of withstanding a momentary overload of 2.8 times full scale value for one (1) second ON and sixty (60) seconds OFF.
- 1-5 DIMENSIONS & WEIGHT: The tester, including test leads weighs 46 pounds. The overall (maximum envelope) dimensions are eighteen (18) inches wide, fifteen (15) inches deep and twelve (12) inches high,
- 1-6 POWER REQUIREMENTS: No external power other than the vehicle under test producing D.C. power to the values noted in Table I is required.
- 1-7 ENVIRONMENTAL REQUIREMENTS: The LVR-3E tester is capable of a low storage temperature of minus (-) 63 F +/-3 F and a high storage temperature of plus (+) 155 F +/-3 F.
- The tester, and leads, are capable of sustaining relative humidity conditions of 93 to 97 percent at a +75 F ambient temperature for limited and reasonable time periods. After exposure to high or low extreme temperature conditions the LVR-3E tester must be temperature stabilized to ambient operating conditions of +30 F., to +112 F. before vehicle testing.
- 1-8 LIST OF ITEMS FURNISHED (LOOSE): The model LVR-3E tester assembly consists of the following items and accessories. See Figure 2.

	PART NO	DESCRIPTION	QTY
a	LVR-1000	Final Assy - Tester	1
b	LVR-1055	Manual	2
c	LVR-1276	Lead - Blk - Volt/Field	2
d	LVR-1277	Lead - Red - Volt/Field	2
e	LVR-1278	Lead - Jumper	1
f	LVR-1279	Lead - Red - 100A	1
g	LVR-1280	Lead - Blk - 100A	1
h	LVR-1281	Lead - 500A	1

NOTE

Two copies of the test set technical manual are provided in the storage compartment pocket on the inside of the top cover

Equipment Required But Not Supplied. Adapter Set, Engine, Electrical Test, NSN 4910-00-348-7600, is required for use with the test set, but is not supplied with the test set.



FINAL ASSEMBLY (ASSY NO. LVR-1000)

FIGURE & INDEX NO.	SUN PART NO.	DESCRIPTION	REF. SYMBOL	QTY PER TESTER
2 - 1	LVR-1055	Manual		2
- 2	LVR-1210	Lid, Storage		1
- 3	1489-4	Bumper		4
- 4	675-60	Screw, 1/4-20x3/4	H.H. Steel	4
- 5	409-18	Nut, H.H. 1/4-20	MS35967-2	4
- 6	604-21	Lockwasher, 1/4		4
- 7	400-20	Flatwasher, 1/4		4
- 8	LVR-1281	Lead - 500A	MS27183-10	1
- 9	LVR-1278	Lead, Jumper		1
- 10	LVR-1221	Case Assembly		1
- 11	LVR-1276	Lead - Black - Field/Volt		2
- 12	LVR-1277	Lead - Red - Field/Volt		2
- 13	LVR-1225	Control Panel Assy		1
- 14	LVR-1280	Lead, Black - 100A		1
- 15	LVR-1279	Lead, Red - 100A		1
- 16	LVR-5000	Decal, Elec. Schematic		1
- 17	LVR-1274	Washer, Stud. SS	Southco Inc. #85-34-201-20	2
- 18	LVR-1272	Stud, Wing Head	Southco Inc. #85-12-120-16	2
- 19	LVR-1273	Receptacle	Southco Inc. #85-47-101-15	2
- 20	LVR-1220	Top Cover Assembly		1
- 21	LVR-1270	Screw P.H.		18
- 22	LVR-1271	Speed Nut	Tinnerman #C8047-1024-1	18
- 23	400-36	Flatwasher, #10		18
- 24	608-304	Rivet 1/8 Dia. .065/.125 Grip		10
- 25	LVR-1211	Compartment, Handbook		1

- 1-9 LIST OF ITEMS FURNISHED (ATTACHED COMPONENTS):
The LVR-3E tester consists of the following major assemblies.
- | | | |
|---|----------|----------------------------|
| a | LVR-1000 | Final (External) Assy |
| b | LVR-1225 | Control & Instrument Panel |
| c | LVR-1260 | Link Bar Assy |
| d | LVR-1250 | Load Resistor Assy |
- 1-10 TOOLS & TEST EQUIPMENT
- 1-10-1 TOOLS: No special hand tools or wrenches are required to disassemble or reassemble any component of the LVR-3E tester.
- 1-10-2 TEST EQUIPMENT: To test the LVR-3E tester for faults or accuracy the following test equipment is required.
- | | |
|----|--|
| a | Voltmeter, 0.25% accurate, 0-50 millivolts, 0-50 volts scales minimum . |
| b | Direct current power supply, filtered, regulated, variable 0-30 V minimum, 0-1 Amp.
Vernier voltage adjustment must provide 5 to 50 millvolt range for ammeter calibration. |
| c. | Shunt, 100 Amp, 50 mV, 0.25%. |
| d. | Ohmmeter 0-100 ohms, Simpson 260 or equivalent. |
| e. | D.C. power supply, adjustable 5-30 volts, 100 Amp filtered, 5% regulation. |
- 1-11 WARRANTY INFORMATION. The contractor certifies that the tester is in compliance with all the terms and requirements of contract number DAAA09-84-C-0068 and its amendments at the time of delivery.

SECTION II

INSPECTION & PREPARATION FOR USE

- 2-1 INSPECTION (INITIAL): Upon initial receipt of the LVR-3E tester open the cover and inspect the control instrument panel for broken binding posts, meters, switches and any other components or items that appear damaged or missing. Inspect the leads for damage and quantities.
- 2-2 INSPECTION (GENERAL): If further inspection of the LVR-3E tester is necessary remove the instrument/control panel from the lower case by removing the screws that support the panel to the case. Remove the lower panel heat shield and check all wiring, connections, resistors and components for looseness, chafing or other damage. Tighten connections and repair or replace damaged items.
- 2-3 PREPARATION FOR USE: The LVR-3E tester is shipped ready to use. Position the tester on a horizontal surface where the air inlet openings are not obstructed on the bottom and front of the tester. Open and lay back the top cover and adjust the meter pointers to read zero.

SECTION III

OPERATING INSTRUCTIONS

3-1

General. Test requirements and test values for various items undergoing test will vary. Before using the test set to test any component or system, refer to the applicable technical manual or manufacturer's literature for that component or system to ascertain what tests are to be performed and what test values should be. Personnel performing tests should have a good understanding of the operating principles of the item being tested. The operating instructions in this chapter are typical; adapt these instructions in accordance with the test requirements and test values specified in the literature for the item that is to be tested.

NOTE

All tests are performed with the item being tested installed in the vehicle.

THEORY OF OPERATION: The LVR-3E tester indicates and absorbs D.C. Electrical Power as generated by the automotive type electrical systems. The tester consists of two basic circuits, the "Load Circuit" and the "Field Circuit", and is operational on 12 or 24 volt D.C. systems.

The Load Circuit, or Ammeter Circuit, utilizes a rheostat to induce a load on the vehicle output electrical circuit. The energy is converted to heat by wire wound resistors and the heat is rejected to atmosphere by the tester cooling fan system.

The current is displayed on a four (4) scale ammeter up to 100 amperes self-contained and up to 500 Amp with external shunt. Other components of the Load Circuit consists of binding posts, shunts and switches. The Load Circuit allows use of the ammeter and load bank, independent of each other and also in series with each other. The load bank is variable over a current range of 5 to 100 amperes, within 0.5 ampere increments at the voltage specified herein.

The field circuit utilizes a rheostat which has an OFF (open) position and two binding posts independently connected. The field rheostat can be connected to the field winding of the generator and vary its voltage output by manually adjusting the rheostat.

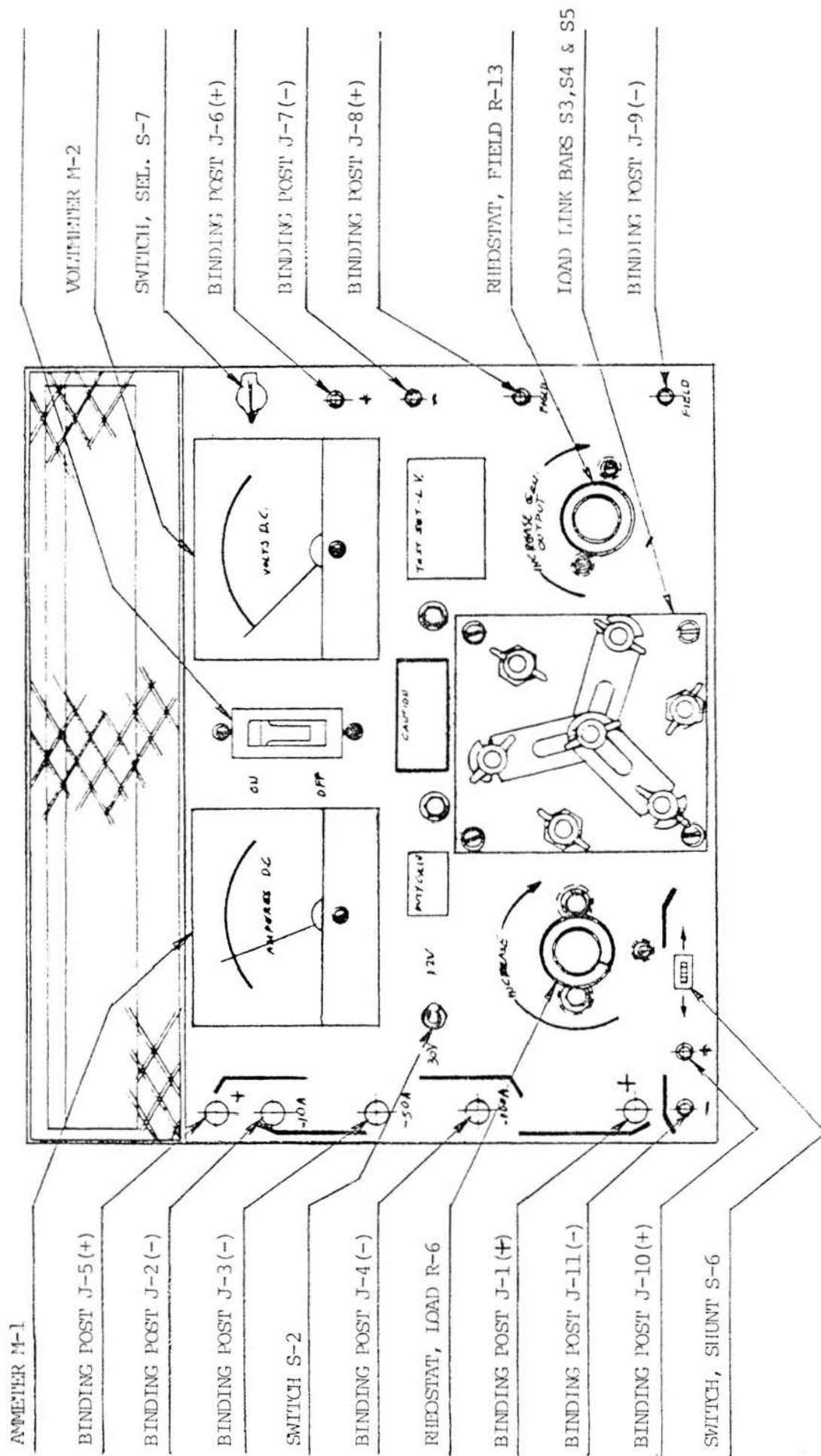
The Voltmeter Circuit consists of a four (4) scale voltmeter up to 50 volts D.C. with a range selector, rotary switch and two binding posts.

Other Devices & Functions: A Load Bank Switch is provided to disconnect the load. The switch is rated at 100 amperes at 30 volts. The load link bars, or shorting bar assembly, are the load switches. When the link bars are positioned and secured in the selected voltage and amperage ranges the links enable the circuit to be distributed to respective resistors and circuits of the LVR-3E tester.

The ammeter and voltmeter of the LVR-3E tester can be used for testing purposes independently of the tester itself.

3-2	DEFINITION & FUNCTION OF COMPONENTS (Top Side of Control/Instrument Panel)	
3-2-1	Voltmeter (M2)	- Indicates D.C. Voltage.
3-2-2	Ammeter (M1)	- Indicates D.C. Current.
3-2-3	Circuit Breaker (S1)	- Disconnects Load Bank.
3-2-4	Selector Switch (S7)	- Selects Voltage Ranges.
3-2-5	Switch - Slide (S6)	- Selects internal or external Shunt.
3-2-6	Switch - Toggle (S2)	- Selects 12 or 30 Volt input to variable load.
3-2-7	Binding Post (J6)	- Pos, 10A, Voltmeter Terminal.
3-2-8	Binding Post (J8)	- Post, 10A, Field Control Terminal.
3-2-9	Binding Post (J10)	- Pos, 10A, External Shunt Terminal.
3-2-10	Binding Post (J7)	- Neg. 10A, Voltmeter Terminal.
3-2-11	Binding Post (J9)	- Neg, 10A, Field Control Terminal.
3-2-12	Binding Post (J11)	- Neg, 10A, External Shunt Terminal.
3-2-13	Link Bar (S3)	- 12/30 Volts - for Resistors R2 & R8.
3-2-14	Link Bar (S4)	- 12/30 Volts - for Resistors R3 & R9.
3-2-15	Link Bar (S5)	- 12/30 Volts for Resistors R4/R5 & R10/R11.
3-2-16	Binding Post (J1)	- Pos, 100A Input Ammeter & Load.
3-2-17	Binding Post (J2)	- Neg, 10A Ammeter & Load.
3-2-18	Binding Post (J3)	- Neg, 50A Ammeter & Load.
3-2-19	Binding Post (J4)	- Neg, 100A Ammeter & Load.
3-2-20	Binding Post (J5)	- Pos, 100A Ammeter & Terminal.
3-2-21	Resistor, Variable (R6)	- Load - 0-15 Amperes
3-2-22	Rheostat (R13)	- Field Control, Generator Output, 70 Ohms.

NOTE: SEE FIGURE 3



CONTROL PANEL

FIGURE 3

3-3

INITIAL ADJUSTMENTS & CONTROL SETTINGS: Before any power or leads are connected to the LVR-3E tester the Controls MUST be positioned as follows:

- a Position the CIRCUIT BREAKER (S1) to the "OFF" position.
- b Rotate the VARIABLE CONTROL (R6) fully Counter-clockwise to the "OFF" position.
- c Rotate the FIELD CONTROLS (R13) Counter-clockwise to the "OFF" position or in the "OPEN" zone indicated on the Control panel.
- d. Position the VOLTAGE RANGE SELECTOR (S7) to the "OFF" position.
- e Verify that the Ammeter and Voltmeter read zero. Adjust for zero by rotating the adjustment screw of each meter as required. The LVR-3E tester must be in a horizontal mode.

CAUTION

Make sure that air flow through the slots in the test set case is not restricted.

3-4

START-UP (INTERFACE TO VEHICLE)

CAUTION

THE CIRCUIT BREAKER MUST BE IN THE OFF POSITION

CAUTION

Heavy currents are measured by the test set. Loose connections can result in damaging overheating and/or arcing.

When connecting cable assemblies, connect the pin terminal end of the cable assemblies to the test set binding posts, and connect the electrical clip end to the equipment undergoing test. Make sure all connections are tight.

Disconnect the clip ends of the cable assemblies from the equipment undergoing test before making any binding post connections or changes.

- a Connect the test lead tip plugs to selected and proper range binding posts before connecting test lead clips to the Circuit(s) under test.

CAUTION

ALWAYS DISCONNECT TEST LEAD CLIPS BEFORE CHANGING PANEL CONNECTIONS TO PREVENT ARCING AT THE BINDING POSTS.

- b Verify that the Variable Load Bank switch is in the OFF position and the Field Control is in the OFF or OPEN position. The Volt Range Selector switch is to be in the OFF position. Also verify that all LVR-3E tester ventilation openings are not obstructed.

CAUTION

DO NOT EXCEED THE DUTY CYCLE OF 10 MINUTES ON AND 10 MINUTES OFF.

- c Position the selected load link bars to the proper voltage posts (12 volts or 30 volts) and to the current range selected (12-1/2 amperes, 25 amperes or 50 amperes). Unused link bars are to be positioned in the "OFF" position by "locating" the end of the bar(s) into the projecting pins of the board. Secure the load links assembly by finger tightening all wing nuts.

EXAMPLE: 12 Volts and 25 Amperes range selection:

TASK: Loosen Center terminal wing nut and all other wing nuts securing link bars.

Position the link bar in the 25 ampere zone to the 12 volt post indicated. Position the remaining links to the OFF position by positioning them in the slot to storage pin position. Tighten the link bar wing nut, and the Center terminal wing nut.

NOTE: For 100 Amperes load at
12 Volts or 30 Volts, all
three (3) load link bars
must be connected and secure.

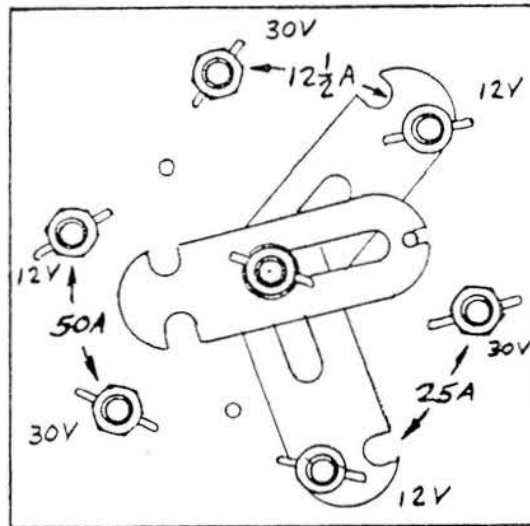
See Figure 4 for additional typical Hook-ups.

To use the load bank and measure current connect the test leads to binding posts designated as "Ammeter and Load".

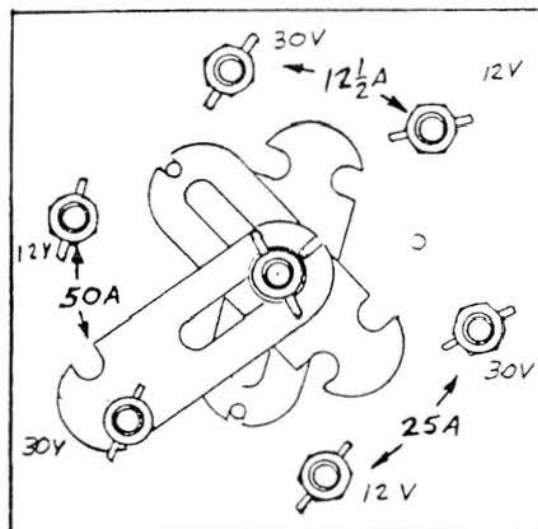
To measure current only through an external circuit connect the test leads to binding posts designated as "Ammeter only". Load bank switch shall be in the "OFF" position.

To use load bank only connect the positive test lead to positive binding post designated as "Ammeter and Load" and the other lead to positive binding post designated as "Ammeter only". Reversing the input polarity will cause reversal of the air flow and reduce the cooling efficiency.

- d Position the variable load selector toggle switch to the 12 or 30 volt range.



LOAD LINK BAR POSITIONED FOR 12 VOLT OPERATION AND 37-1/2 AMPERE RANGE (2 BARS ENGAGED AT 12 VOLT POSTS)



LOAD LINK BAR POSITIONED FOR 30 VOLT OPERATION AND 50 AMPERE RANGE (1 BAR ENGAGED AT 30 VOLT POST)

LOAD BAR POSITIONING EXAMPLES

FIGURE 4

3-5 CONTROLS & METERS: The operator should be familiar with the LVR-3E controls/instrumentation and their functions before testing vehicle electrical systems. The following instrument panel component functions are defined as follows:

3-5-1 Ammeter D.C. The ammeter is a four scale instrument with zero-adjusting button on the front. Meter indicates both positive and negative current readings (forward and reverse currents). Correct polarity must be observed when making connections. Scale zeros are located approximately 1/3 scale from left end. Ammeter is used for measuring generator and starter currents, testing voltage regulator, and making other dc tests. Reverse current readings are noted when making voltage regulator cutout relay tests.

Connections to ammeter are made to AMMETER binding posts (for the three lower reading scales) using test leads with the larger tip plugs. Connect red tip plug of test lead to + (positive) binding post, and black tip plug to desired -10A, -50A, or -100A (negative binding post).

The high reading scale, 500 amperes dc, requires the use of the EXTERNAL SHUNT, (P/N LVR-1281). When the positive post of the vehicle's battery is grounded (instead of the negative post) the ammeter polarity must be reversed from what it is with negative ground.

Volts D.C. The voltmeter is a four scale instrument with zero adjusting button on the front. It is used for measuring voltages and voltage drops (or loss) across cables and cable connections. A voltage selector switch denotes scale ranges for usage.

Voltmeter circuit is completely independent of the load bank and ammeter and is connected to positive and negative binding posts. Voltage measurements can be made anywhere in the test circuit setup by using accessory leads provided. Observe polarities when connecting test leads to binding posts (red test lead to positive; black test lead to negative). Voltage of battery determines which voltmeter scale to use, except where different scales are specified in some of the test procedures. When unsure of voltage magnitude always use highest scale available.

- 3-5-3 Load Bank Switch. Load bank switch is used to energize selected fixed and variable load increments. It is rated at maximum capacity of the load bank and can be used as a shock load switch.
- 3-5-4 Field Rheostat. Field rheostat is a wire-wound, power type, variable resistance which opens the circuit when turned to OPEN position. Clockwise rotation decreases its resistance. Field rheostat is connected in series with field circuit of dc generator for manual control of generator output. The field rheostat will carry up to 15 amperes direct current.
- Connections to field rheostat are made to FIELD RHEOSTAT binding posts.
- 3-5-5 External Shunt 500A. External shunt element is enclosed in a rubber cover, and has attached to it two short heavy leads with heavy clips. Two long light leads with pin plugs, also attached to the shunt, must be connected to the EXT. SHUNT binding posts on the panel.
- Connect heavy clips in series in the circuit where current is to be measured, observing polarity (red to positive (+) and black to negative (-) side of the circuit). Connect tip plugs to EXT SHUNT 500 AMP binding posts observing polarity.
- Slide switch designated "External - Internal" must be moved to "External" position when using 500 Amp Shunt.
- The slide switch switches only the positive lead from the internal shunt to the external shunt positive jack.
- 3-5-6 Variable Load Selector. The variable load selector switch connects a fixed load increment in series with the variable load to accommodate 12 & 30 Volt inputs and limit maximum current when variable load is set at zero ohms.
- At the same time the selector introduces a dropping resistor in series with the fan motor to make it compatible with the 30 volt input.
- 3-6 NORMAL OPERATION: After initial Adjustments and Control Settings (3-3), and Start-Up (3-4) have been completed the tester is ready for performance testing.

3-6-1

Turn the Circuit breaker to the ON position and test the various Electrical Circuits as noted in Section IV.

CAUTION

The discharge air flow grille must be unobstructed. Avoid any objects or beverages that can enter the grille accidentally.

WARNING

Contact with the exhaust pipe of the test vehicle may result in burns. Check the exhaust pipe before connecting or disconnecting adapters.

CAUTION

Observe load bank duty cycle.

NOTE

The adapters are part of Adapter Set, Engine, Electrical Test, NSN 4910-00-348-7600.

NOTE

Refer to the pertinent specifications for the particular generator undergoing test for other generator data.

NOTE

Always Disconnect The Tester from the Vehicle after each Test is completed.

SECTION IV

IV VEHICLE TESTING FOR STARTER & CHARGING CIRCUITS

- 4-1 Test Lead Connections. The test lead connectors given in the following tests are the circuits where negative post of battery is grounded (negative ground). When positive post of battery is grounded, reverse test lead clips of ammeter and voltmeter for correct indication.
- 4-2 Battery Cell Voltage. Fasten red tip plug in VOLTMETER P/N LVR-1226-01 plus (+) binding post, and black tip plug in VOLTMETER P/N LVR-1226-02 minus (-) binding post. Connect red test lead clip to + (positive) post of battery and make connection with black test lead clip to strap between cells to read voltage of a single cell. Read cell voltage; crank engine with ignition off and read cell voltage again while starter is cranking engine. Cell voltage with starter running should be 1.7 volts. Repeat the test with test leads connected across the other cells. A difference of more than 0.2 volt between cells will indicate that the lowest reading cell is bad, however, reserve judgement of battery condition until after starter motor cranking current has been checked. See Figure 5A for test set-up example.
- 4-3 Starter Circuit Voltage Loss (Insulated Circuit).
For negative ground circuits, connect red voltmeter test lead clip #LVR-1226-01 to insulated (not grounded) typical battery post and connect black voltmeter test lead clip #LVR-1226-02 to cable post on starter. For positive ground circuits interchange voltmeter test lead clips. Voltage of battery determines which voltmeter range to use. Pointer will show battery voltage, and then drop while engine is being cranked to show desired insulated circuit reading, which is the voltage loss, across battery cables and solenoid switch contacts. High voltage loss means high resistance in the circuit. While starter is cranking engine the reading should not be more than 0.3 volt for starting circuits having two cables and one switch. If reading is too high clean and tighten connections or replace defective cables. The cables may be tested separately by connecting the voltmeter test lead clips across one cable at a time and then cranking the engine. Change to a lower voltmeter scale for a better indication. In 12 volt and high voltage systems the loss may be 0.2 to 0.4 volt loss. A short length of cable (or a strap) should show no voltage loss. See manufacturer's specification for voltage loss (voltage drop) allowable. See Figure 5B for test set-up.

FIGURE 5A: BATTERY CELL VOLTAGE TEST SET-UP (12 VOLT SHOWN)

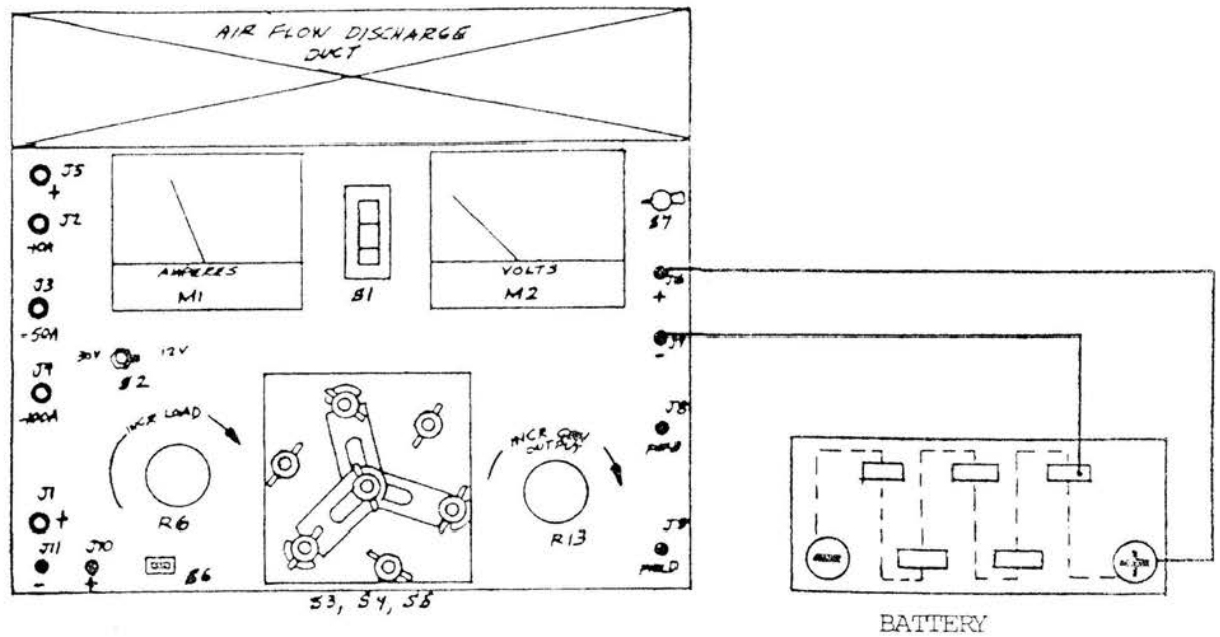
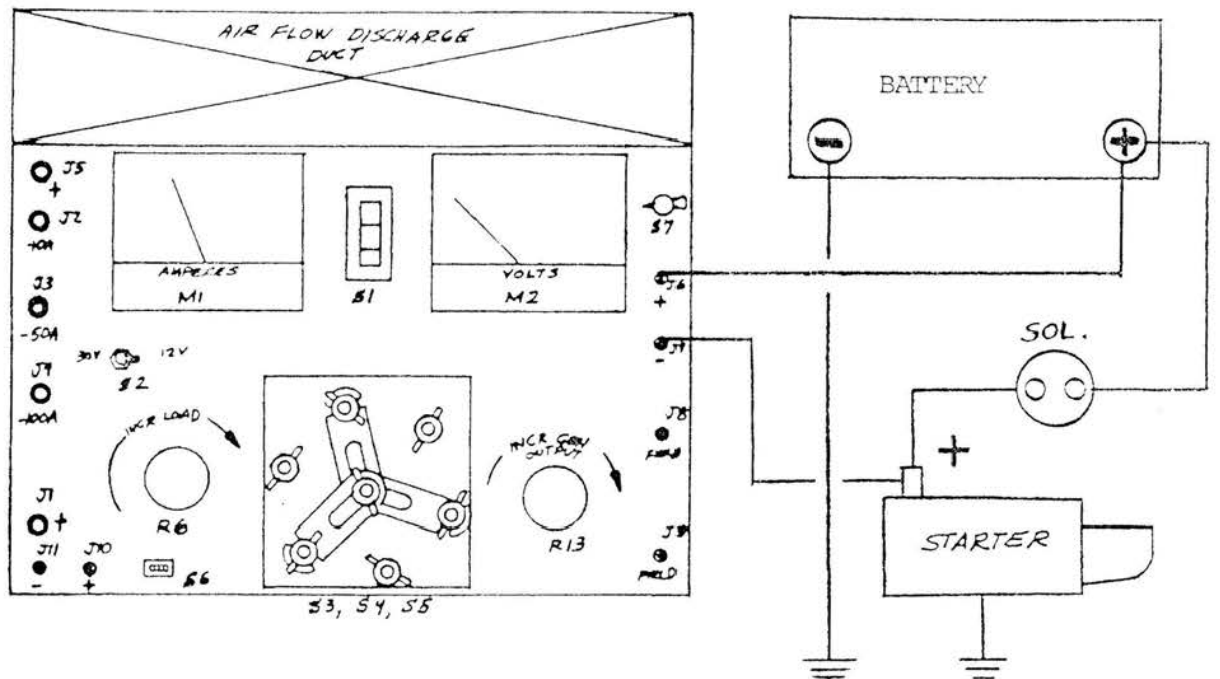


FIGURE 5B: STARTER CIRCUIT VOLTAGE LOSS TEST SET-UP (12 VOLT SHOWN)

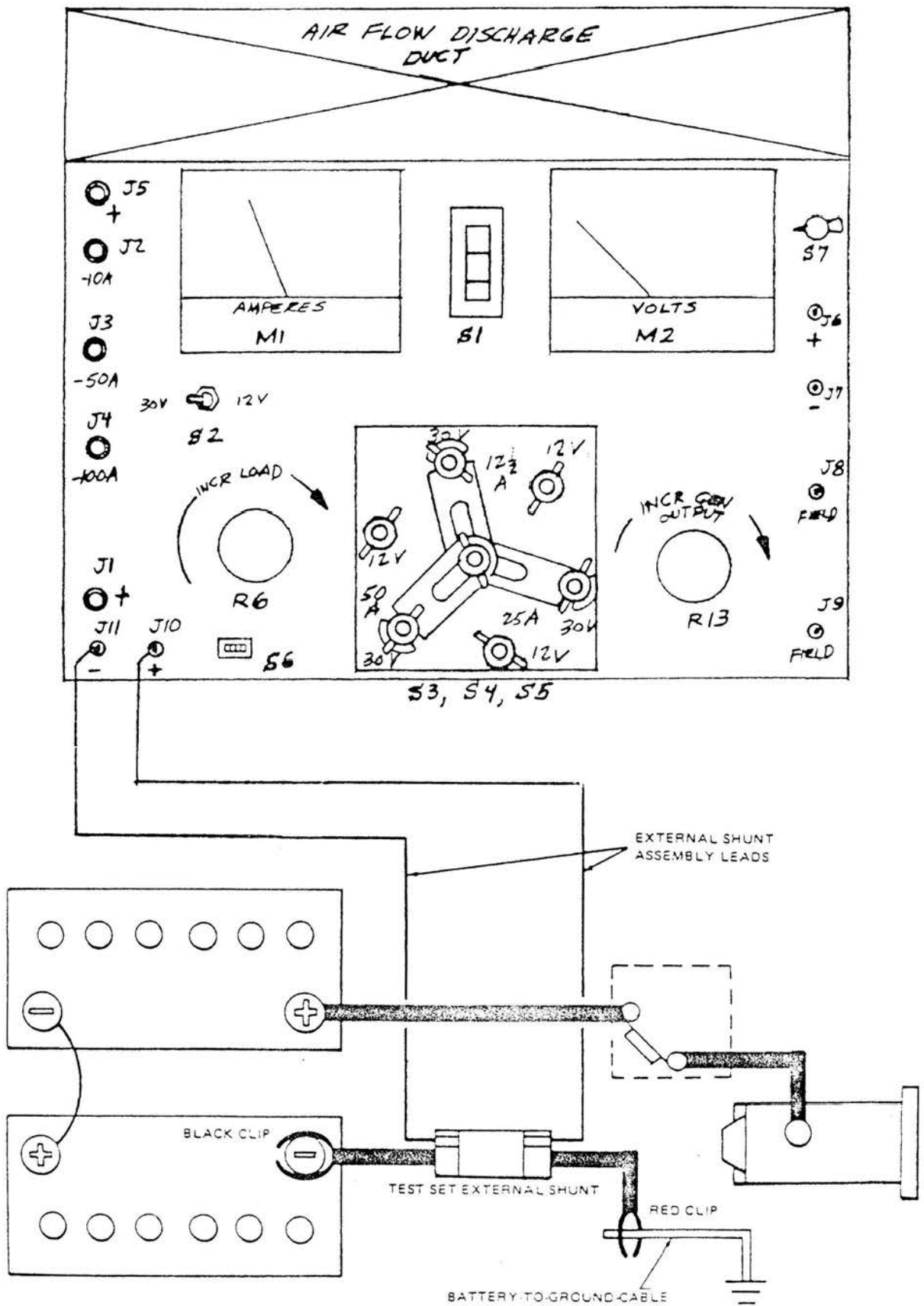


- 4-4 Starter Circuit Voltage Loss (Ground Circuit).
For negative ground circuits, connect red voltmeter test lead clip to body of starter, and black voltmeter test lead clip to grounded post of battery. For positive ground circuits interchange voltmeter test lead clips. Crank engine and read voltmeter using IV scale. Reading should not be more than 0.1 volt.
- After the test has been completed, open the starter motor circuit. Disconnect the test set external shunt, and reconnect the battery-to-ground cable to the battery negative terminal. See Figure 6A for starter circuit voltage loss test set-up.
- 4-5 Starter Motor Amperage Draw. Connect color coded small tip plugs of external shunt to EXT SHUNT binding posts observing polarity. Position EXTERNAL SHUNT slide switch to EXTERNAL position. Disconnect battery cable from starter terminal (or from starter solenoid switch terminal if more convenient) and clip red heavy test clip of external shunt to battery cable. Clip black heavy test clip to starter terminal (or starter solenoid terminal). With ignition off, crank engine and read amperage draw of starter on 0 to 500 scale. If amperage is low the circuit may have excessive voltage loss (high resistance) or battery may be defective. See Figure 7 for typical 24 volt test set-up.
- 4-6 Ignition Primary Circuit Voltage Loss. Slowly crank engine with ignition switch off until ignition breaker points are closed. For negative ground circuits, connect red voltmeter test lead LVR-1226-01 clip to insulated positive post of battery and black voltmeter test lead clip to "battery" terminal of ignition coil. Voltmeter should read only a few tenths of a volt. Change to IV voltmeter range for more accurate reading. For positive ground circuits interchange voltmeter test lead clips. Normally the voltmeter should not read more than 0.2 volt. Return voltmeter to higher range and turn ignition switch off and on several times. Voltmeter should read the same each time switch is turned on. If voltmeter reading exceeds 0.2 volt, isolate the trouble by clipping the test leads across each wire and each connection in turn. The reading across a connection should be zero. If trouble is not found move red voltmeter test lead clip to "distributor" terminal of ignition coil and black voltmeter test lead clip to terminal of distributor terminal and ground, to check internal circuit of distributor. See Figure 6B for ignition primary circuit voltage loss test set-up.
- 4-7 D.C. Charging Systems Types. There are two types of dc charging systems which are referred to as Type A and Type B. The generators and voltage regulators of the two systems have different electrical circuits and are therefore not interchangeable.
- In a Type A system the generator has one wire of its field winding connected internally to the armature terminal. To complete the circuit the other wire which is connected to the field terminal is connected externally through the voltage regulator contacts to ground.

The diagram illustrates the 'AIR FLOW DISCHARGE DUCT' circuit. The main panel contains the following components and connections:

- Meters:** Two meters are shown, labeled 'M1' (with 'AMPERES' below it) and 'M2' (with 'VOLTS' below it).
- Switches:** A central switch labeled 'S1' is shown. To the left, there are several smaller switches labeled 'J5', 'J2', 'J3', 'J7', 'J1', 'J11', and 'J70'. To the right, there are switches labeled 'S7', 'S8', 'S9', and 'S10'.
- Resistors:** A resistor labeled 'R6' is shown with a 'MIC LOAD' label. Another resistor labeled 'R13' is shown with a 'MIC. COIL OUTPUT' label.
- Other Components:** A component labeled 'S2' is shown with a '30V 12V' label. A component labeled 'S6' is shown with a '100A' label.
- Power Source:** A 'BATTERY' is connected to the circuit. The positive terminal is connected to a switch labeled 'IGH. SW' (Ignition Switch).
- Coil and Distributor:** The circuit includes a 'COIL' and a 'DIST.' (Distributor) connected to the battery.

The diagram is a detailed schematic showing the electrical connections between these components, including ground connections and various wiring paths.



(Typical 24 Volt)
Starter motor amperage test, test setup.

In a Type B system the generator has one wire of its field winding connected internally to the frame (ground). To complete the circuit the other wire which is connected to the field terminal is connected externally through the voltage regulator contacts to the armature. See Figure 8A and 8B for pictorial definitions of types A and B.

ALTERNATOR SYSTEM TEST:

Precautions: When working with alternators, observe the following precautions to prevent damage to the alternator or regulator.

Alternator Load Test. This test checks the alternator output capacity. Refer to the pertinent alternator technical literature for test data and specifications. Perform this test as follows:

Never reverse battery connections to the alternator. Always check the battery connecting cables with a voltmeter to determine polarity before making any connections to an alternator. Make sure that the negative battery cable is connected to the alternator frame, and the positive battery cable is connected to the alternator positive terminal.

Never disconnect the voltage regulator sensing lead (ignition lead) while the vehicle engine is running. This lead supplies battery voltage information to the regulator. If it is removed the regulator will burn out trying to reach 28 volts.

Never ground the alternator output terminal. The internal resistance of an alternator is very low; therefore, an external short circuit will overload all regulating and generating circuits, resulting in burnout.

Never operate the alternator with the ignition sensing (voltage sensing) terminal energized unless a load is connected to the alternator output.

Never try to polarize an alternator. It is unnecessary, and could result in damage.

4-8

Generator Polarity. The dc generator will build up voltage in either direction depending on the polarity of the residual magnetism in the pole shoes. After a generator has been repaired it should be polarized before starting the engine.

Type A generators are polarized by momentarily touching a jumper lead between the battery terminal ("B" or "BAT") and the armature terminal ("A" or "GEN") of the voltage regulator.

Type B generators are polarized by disconnecting the field lead from the field terminal ("F" or "FIELD") of the voltage regulator and momentarily touching it to the battery terminal ("B" or "BAT") of the voltage regulator.

FIGURE 8A: TYPE "A" CHARGING SYSTEM

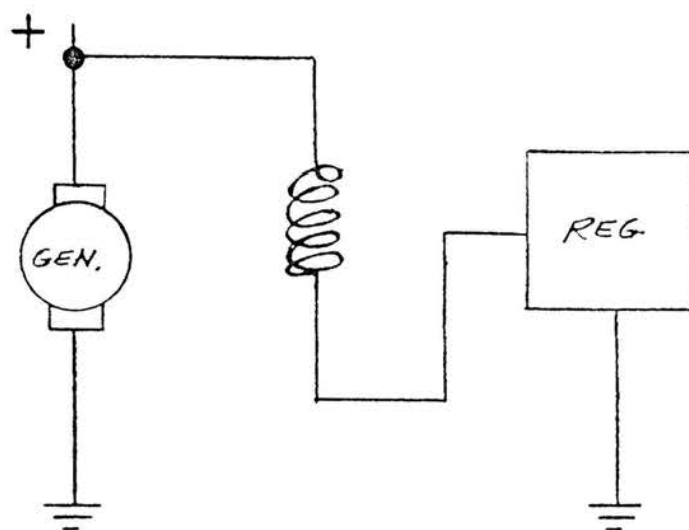
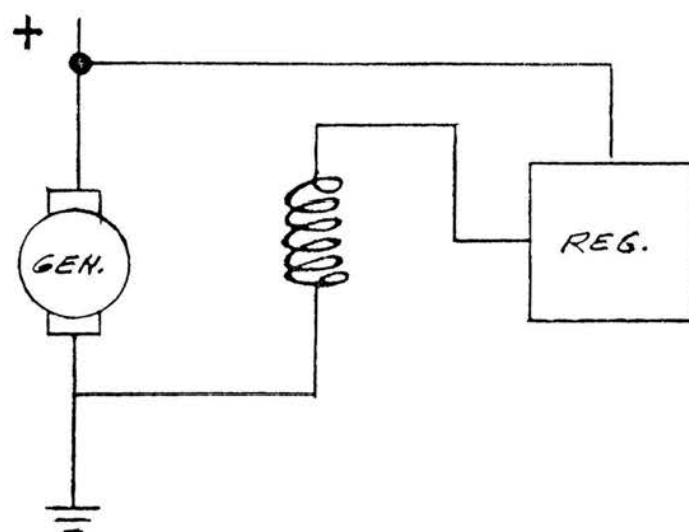


FIGURE 8B: TYPE "B" CHARGING SYSTEM



4-9 Finding "B" Terminal of Voltage Regulator. With engine not running battery voltage should appear at only one terminal of the voltage regulator the "B" (or "BAT") terminal.

4-10 Finding Type of Charging System. Disconnect battery wire from "B" terminal of voltage regulator. Clip red ammeter test lead (+) to "B" terminal of voltage regulator and black ammeter test lead (-50A) to disconnected battery wire (with negative ground system).

Disconnect field wire of generator from "F" (or "FIELD") terminal of voltage regulator. Using test leads connected to FIELD RHEOSTAT binding posts, clip one test lead to lug of removed field wire and the other test lead to a good ground ("F" terminal of voltage regulator is unconnected.)

Start engine and run at about 1500 rpm. Turn FIELD RHEOSTAT knob full clockwise. If D.C. AMMETER shows a reading the charging system has a Type A electrical circuit. If D.C. AMMETER does not show a reading, remove the test lead from the ground connection and clip it to the "A" (or "GEN") terminal of the voltage regulator (the other test lead remains clipped to the field wire). If D.C. AMMETER now shows a reading, the charging system has a Type B electrical circuit.

4-11 Generator Inspection. The generator should be visually inspected before making electrical tests. Inspect generator for loose bearings, worn brushes, burned commutator, loose connections, and loose fan belt.

4-12 Generator Output Current. Disconnect battery wire from "B" terminal of voltage regulator. Using ammeter test leads connect "B" terminal to (+) binding post of ammeter (if negative post of battery is grounded), and connect battery wire to -100A binding post of ammeter. For a positive ground circuit interchange heavy ammeter clips.

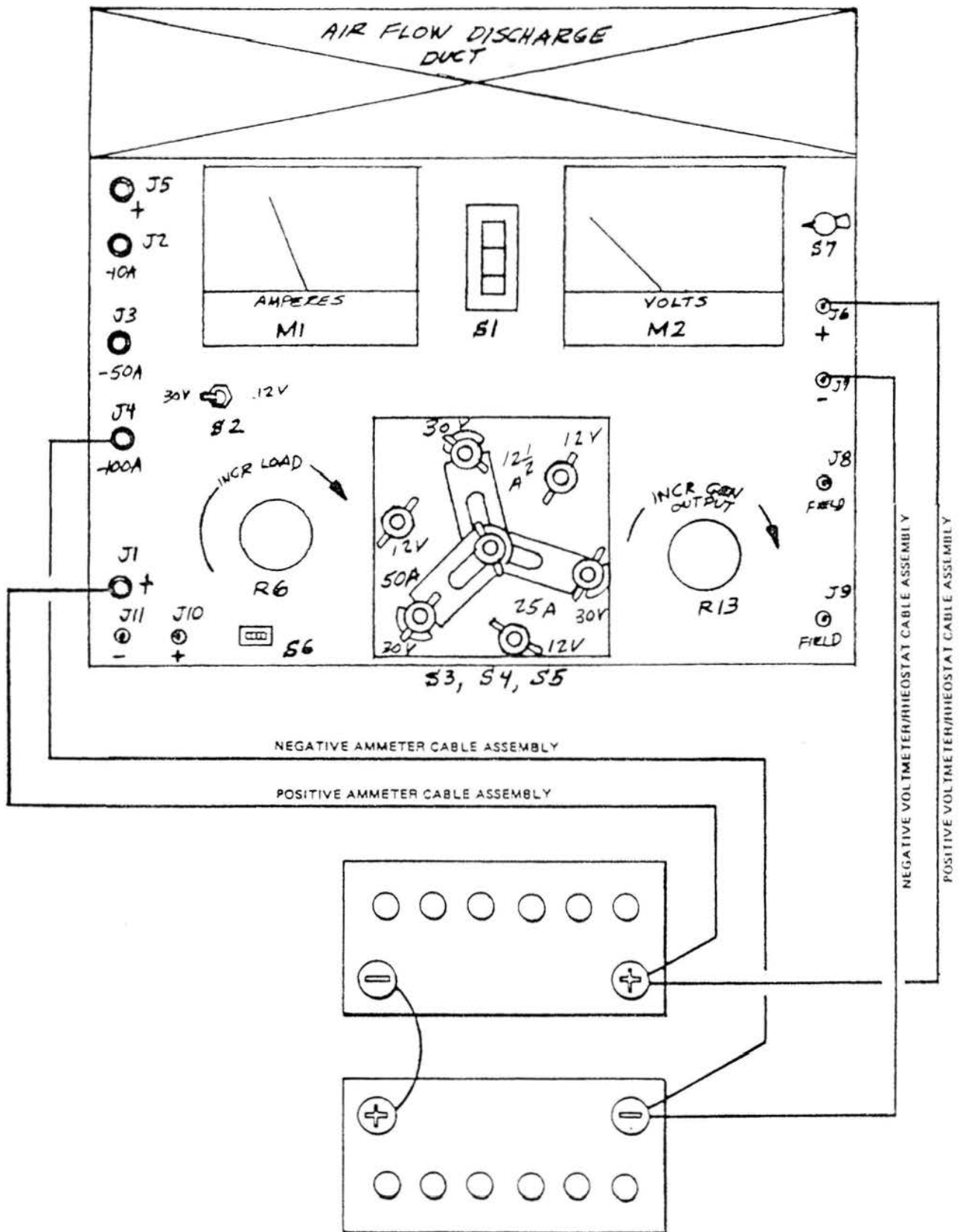
Connect one FIELD RHEOSTAT test lead clip to field terminal ("F") of generator, and the other test lead clip to ground if charging system is a Type A (field winding externally grounded), or to Armature terminal ("A") of generator if charging system is Type B (field winding internally grounded). Start the engine and increase speed to approximately 1700 rpm. Turn FIELD RHEOSTAT clockwise to increase generator output until ammeter reads 1-1/2 times the rated output of the generator. Turn FIELD RHEOSTAT to OPEN position immediately.

CAUTION

Do not run generator overloaded for more than 5 seconds.

- 4-13 Charging Circuit Voltage Loss (Insulated Circuit). With ammeter and field rheostat connected adjust engine speed and FIELD RHEOSTAT until ammeter indicates 20 amperes. If circuit has negative ground, clip red voltmeter test lead to "A" terminal of generator, and black voltmeter test lead to positive post of the battery. If positive post of battery is grounded interchange voltmeter test lead clips. The voltmeter should not read more than 0.8 volt. Change selector switch to a lower voltage to read voltage more accurately.
- 4-14 Charging Circuit Voltage Loss (Ground Circuit). With engine running and ammeter indication 20 amperes clip red voltmeter test lead to grounded post of battery (with negative ground) and black voltmeter test lead to the generator frame. The voltmeter should not indicate more than 0.1 volt. If positive post of battery is grounded interchange voltmeter test lead clips.
- 4-15 Voltage Regulator and Other Tests. For procedures to use when testing voltage regulators, and other electrical components of the engine, refer to the applicable voltage regulator or engine Instruction Manuals.
- 4-16 Miscellaneous Test Set-ups. See the following figures to interface components being tested to the LVR-3E. Refer to the component manufacturer's specifications or other established electrical values.

Figure 9; 24 Volt Battery Load Test
Figure 10; Single 12 Volt Battery Test
Figure 11; Voltage Regulator Test (TYP. 24 Volt)
Figure 12; Generator Output Test (TYP. 24 Volt)
Figure 13; Alternator Load Test (TYP. 24 V. - 60A.)



24 volt battery load test, test setup.

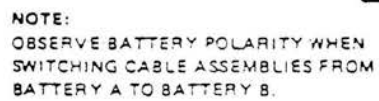


FIGURE 10

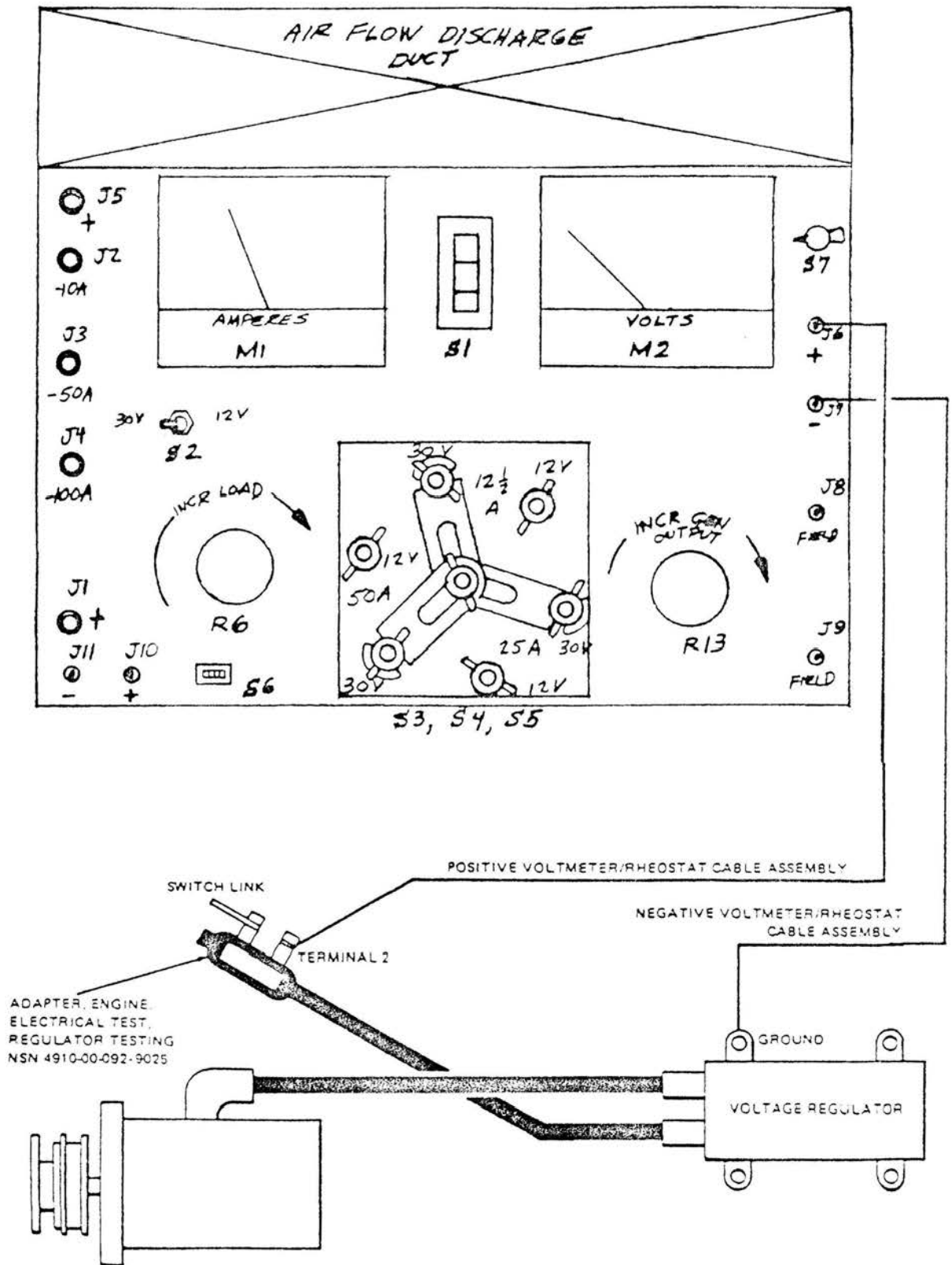
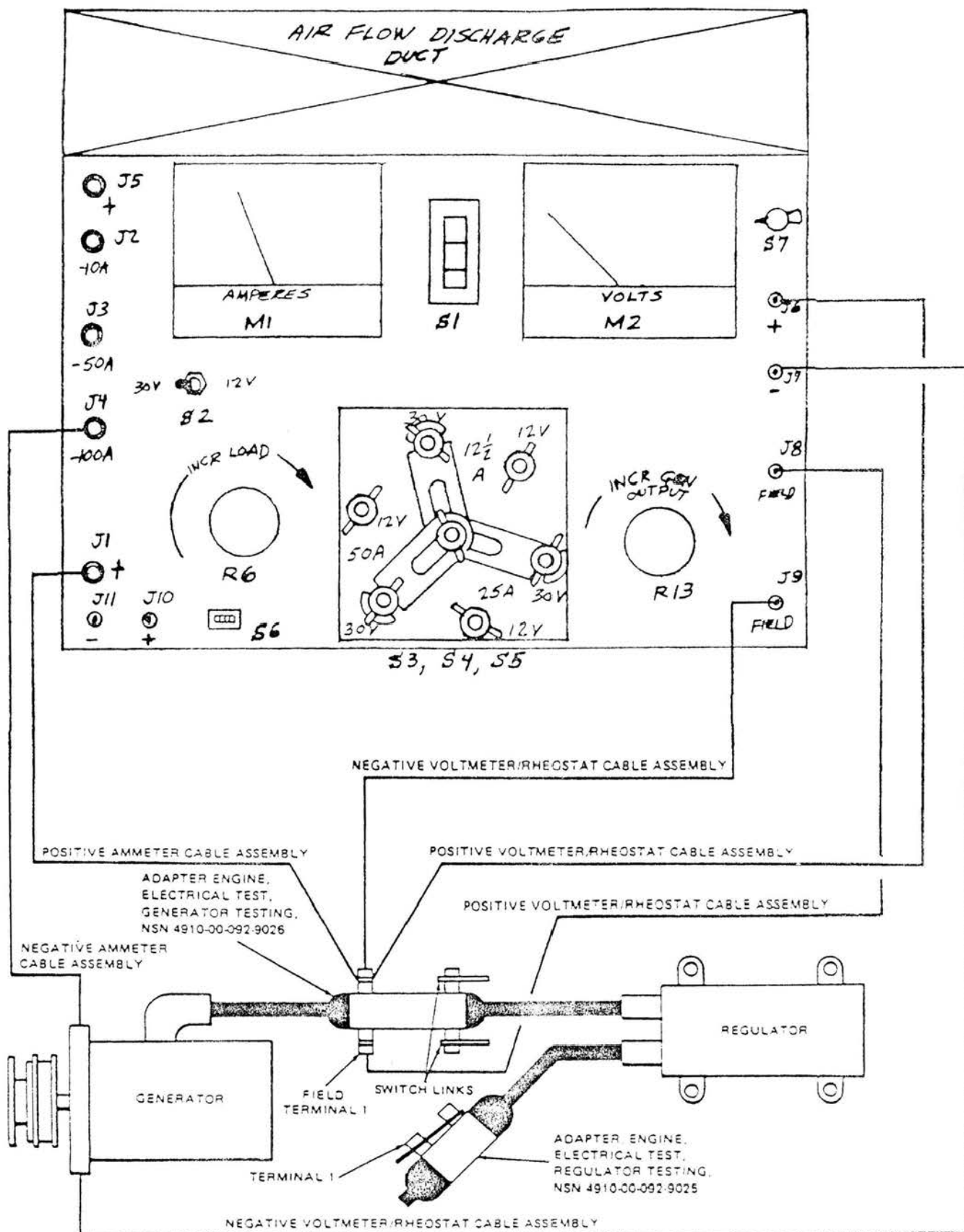
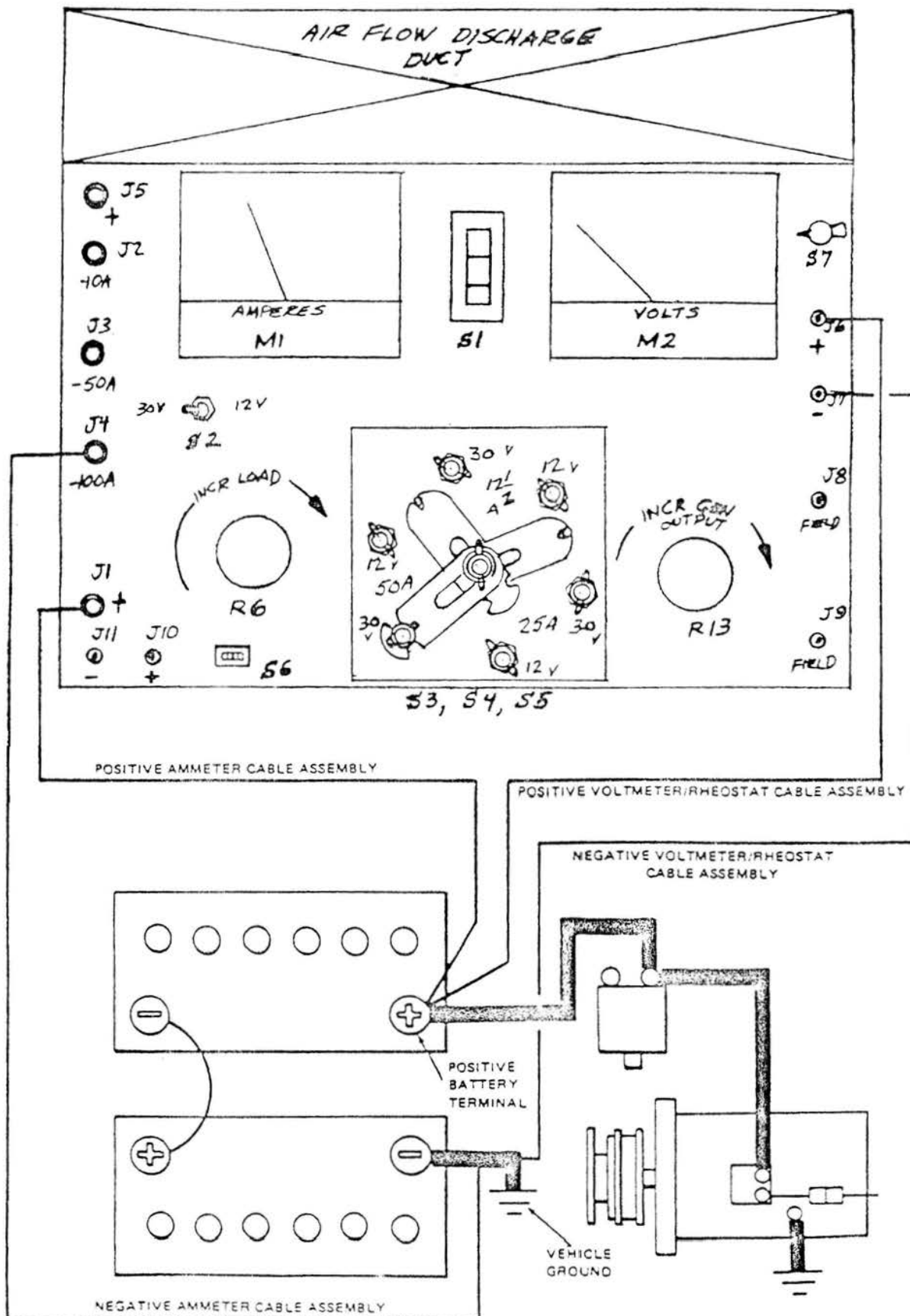


FIGURE 11



(Typical 24 Volt)
Generator output test, test setup.

FIGURE 12



(Typical 60 Amp, 24 Volt)
Alternator load test, test setup.

FIGURE 13

SECTION V

SHUTDOWN

5

Upon Completion of testing proceed as follows:

- a Rotate the load bank rheostat fully counterclockwise to the OFF position.
- b Rotate the field rheostat fully counterclockwise the the OFF or OPEN position.
- c Turn the voltmeter range selector switch to the OFF position.
- d Position the Circuit breaker to the OFF position.
- e Disconnect the test leads first at the vehicle under test, then from the binding posts of the LVR-3E tester.
- f Store the manual and test leads in the compartment of the upper case and latch the case halves closed.

SECTION VI

TROUBLE SHOOTING

6-1 Trouble shooting.

The table below lists troubles which may develop during normal operation of the test set. Their probable cause is indicated together with suggested remedial action which may be performed by operating personnel.

WARNING

To protect personnel, install a wire guard over the fan blade if the test set is to be operated outside its case.

CAUTION

Do not connect an ohmmeter across the test set meter terminals while troubleshooting. The ohmmeter output voltage may damage the meter movement.

NOTE

Disconnect any electrical connections before removing any part from the test set. Tag the connecting leadwires to ensure that they will be reconnected properly during assembly.

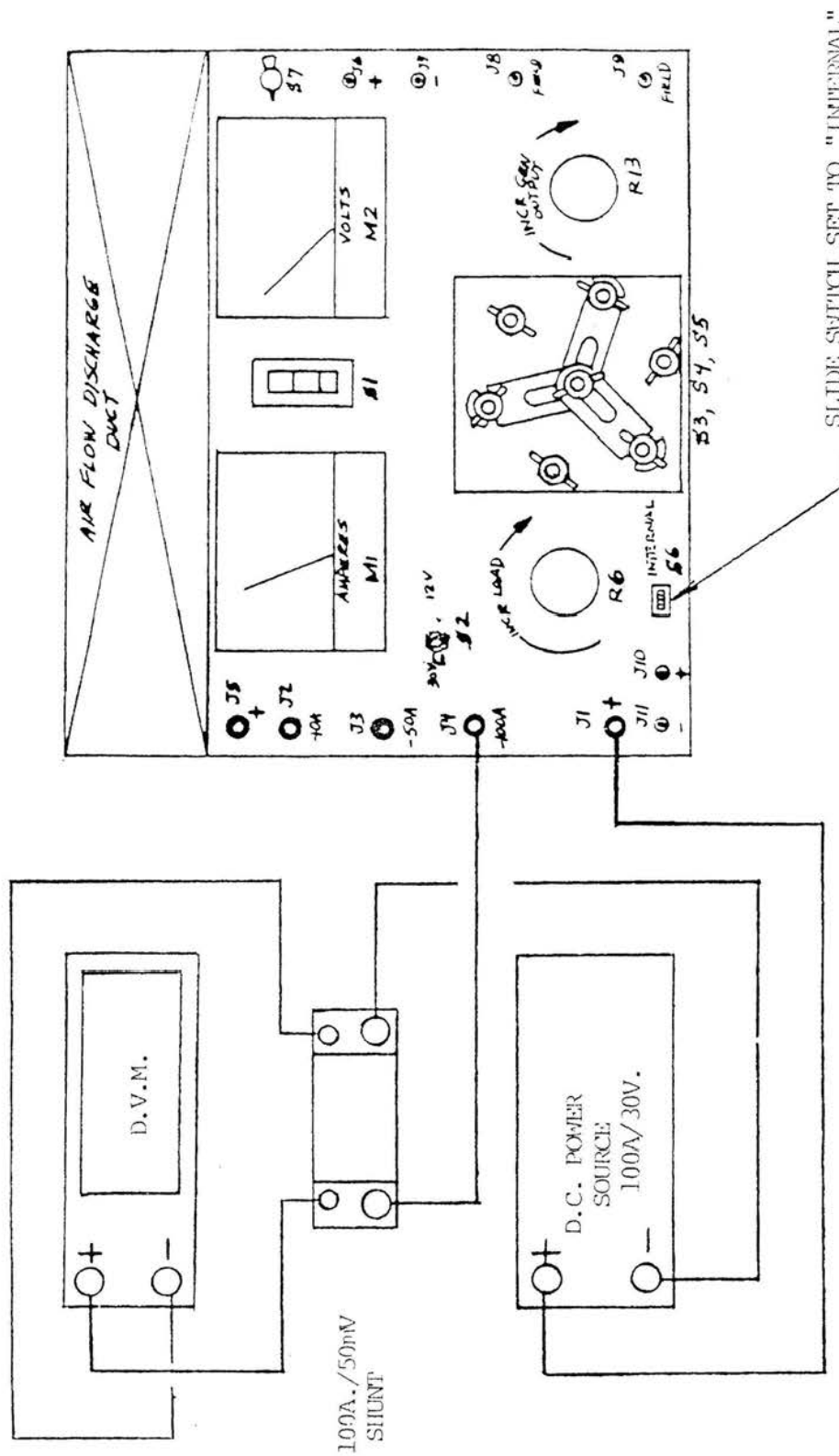
TROUBLE	PROBABLE CAUSE	REMEDY
Test Set is overheating	Air flow intake or exhaust is blocked	Remove obstruction
	Fan Motor inoperative or burned out	Replace motor
	Toggle switch S2, variable load selector is defective	Replace Switch
	Resistor R12 is open (fan will not run at 30 volt input only)	Replace resistor
	Fan blade slipping on motor shaft	Replace blade
	Input voltage too high	Lower input
	Load increments set at lower voltage	Change link bar setting to correspond with input voltage
	Adjacent load resistors are touching each other	Reposition or replace resistors
	Internal wiring is shorted	Replace individual wires
	Heat shields/deflectors are not reassembled properly or are missing	Mount shields properly and install as required
Ammeter is not reading	Meter movement defective, internal meter overload protector is shorted	Replace meter

	Switch S6, "internal-external" shunt is set to "external" or switch is defective	Set switch to correct position or replace
	Wiring between meter and internal shunt open circuited	Replace wiring and repair
	Load bank switch is OFF position or defective	Replace switch
	Load bank resistors or wiring Open circuited or loose	Replace resistors. Check wiring & repair
	Internal shunt R18 defective (10 Amp range only)	Replace shunt
Voltmeter does not read	Meter movement defective; internal meter overload protector is shorted	Replace meter
	Range selector switch S7 is defective	Replace switch
	Jacks J6 or J7 defective	Replace jacks
	Ranging resistors R14, R15 R16, R17 open circuited	Locate and replace defective resistor
Variable load is inoperative or limited in range	Rheostat R6 has open coil; brush is not electrically connected	Replace rheostat
	Knob loose or out of position	Check rheostat & knob position & secure hardware
	Toggle switch S2 defective	Replace switch
	Fixed resistors R1 or R7 open circuited	Replace resistors
Field control generator output inoperative	Rheostat R13 open or winding burned out, brush is defective	Replace rheostat
	Jacks J8 or J9 defective	Replace jacks, check wiring

- 6-2 Instrument Calibration. Both the voltmeter and ammeter can be calibrated without removal from the control panel or operating the load bank. Test equipment is listed in para. 1-10-2.
- 6-2-1 D.C. Voltmeter. In voltmeters when the pointer deflects to the left hand edge of the scale when no voltage is applied may be considered as properly "zero" calibrated with external zero adjustment. To compare accuracy with a standard voltmeter proceed as follows: See Fig. 14.
- a Connect D.C. power supply and standard (test) voltmeter to test jacks J6 and J7, red positive, black negative. Test equipment is listed in para. 1-10-2.
 - b Energize input to power supply.
 - c Compare test set meter readings with that of standard instrument.
Voltmeter circuit accuracy is $\pm 2\%$ of full scale of range selected at 77 degrees F.
Additional 1% variation is allowed when the ambient temperature is $+30$ degrees F or $+112$ degrees F.
- 6-2-2 D.C. Ammeter. The ammeter contains a standard direct current movement rated at -15MA to 0 to $+50\text{MA}$ full scale. It operates from an internal shunt, tapped at 10 Amp, 50 Amp and 100 Amp. When slide switch S6 is in the "EXTERNAL SHUNT" position it is then possible to calibrate the ammeter 50 millivolt movement.
- To compare accuracy with a standard ammeter proceed as follows: See Fig. 15.
- a Connect D.C. millivolt power supply to "EXTERNAL SHUNT" jacks J10 (red) positive and J11 (black) negative. The power supply must have a fine vernier voltage control in a 5 to 50 millivolt range and be transient free during turn-on and turn-off.
 - b. Connect standard D.C. millivoltmeter also to jacks J10 and J11 or to power supply output.
 - c. Energize input to D.C. power supply.
 - d. Compare test set meter readings with that of a standard instrument.
Ammeter circuit accuracy is $\pm 3\%$ of full scale of range selected at 77 degrees F. ambient.
Ammeter movement alone is 50 mV $\pm 2\%$ accurate.
Additional 1% variation is allowed when ambient temperature range is $+30$ degrees to $+112$ degrees F.

To verify accuracy of the ammeter circuit, including the internal shunt proceed as follows: See Fig. 16.

- e. Connect 100 Amp. power supply or other equivalent D.C. source to the test set through a 100 amp external shunt connected in series between the supply and test set.
- f. Connect a 0-50 mV millivoltmeter to the external shunt.
- g. Energize power source.
- h. Select appropriate load and ammeter range on the test set.
- j. Compare test set meter readings with that of a standard instrument.



AMMETER CIRCUIT CALIBRATION

SECTION VII

7

REPAIR

- 7-1 Disassembly (with all power disconnected).
The Control/instrument panel is easily removed from the lower case by the removal of the 18 attaching screws, located on four sides of the Case.
- Turn the panel up-side down and remove the three heat shields to provide maximum access for Component removal and access.
- NOTE: Tag terminals and wires to be removed to simplify reassembly.
- 7-1-1 To remove a wire wound resistor use proper sized open-end and box wrenches. If the entire panel is to be removed tag the leads, remove the attaching hardware and remove the panel by removing four (4) attaching screws that mount the panel assembly to the back brackets of the control panel fabrication.
- 7-1-2 Removal of the Cooling fan motor requires the removal of the fan blade (pull-out) de-soldering of the leads and removal of the associated attaching hardware.
- 7-1-3 To remove the load link board assembly disconnect all leads and remove four (4) screws and washers located on the top side of the Control/instrument panel.
- 7-1-4 Removal of the field and load rheostats requires removal of the leads, knobs and attaching hardware located on the top side of the instrument/control panel.
- 7-1-5 The Circuit breaker is removed from the panel by removal of the two (2) screws and hardware located topside of the panel.
- 7-1-6 The Ammeter and voltmeter are removed from the panel by disconnecting the leads from the meter terminals and the attaching hardware (4 places per meter) located on the underside of the panel.
- 7-2 Repair & Replacement. Other than damaged leads which can be repaired and reinsulated, the only other reparable areas are the rheostat slider contacts that can be furnished with new torsion springs, and or adjusted for seating pressure.
- All other components, circuit breakers, meters, and resistors are non-reparable.

CAUTION

DO NOT SHORTEN THE LENGTH OF ANY WIRE
WOUND RESISTOR SHOULD BREAKAGE OCCUR.
EXCESSIVE HEAT & IMPROPER VALUES WILL
OCCUR.

7-3

Re-assembly is the reverse process of removal of
components as stated in 7-1-1 to 7-1-6.

Be sure that the heat shields are properly positioned
as previous and not damaged or deformed before and
when re-assembling to the lower Case assembly.

Check all hardware for sufficient tightness and
verify that leads or fabrications are not touching
"HOT" electrical areas.

Verify that the rheostat knobs are positioned
properly to the OPEN/OFF position, see 6-1-2b for
adjustment.

SECTION VIII

8

CLEANING & LUBRICATION

The meters have plastic windows. Clean windows with soft cloth. do not scratch plastic. Clean panel and Control knobs. Keep Cables clean and brush corrosion from battery clips. Internally keep the insulating strips, resistive elements and fan blade free of dirt.

No lubrication is required or necessary for any Component of the LBR-3E tester.

WARNING

Provide adequate ventilation both during and after use of trichloroethane. Avoid prolonged inhalation of vapors. Wear rubber gloves.

The use of diesel fuel oil, gasoline, or benzine (benzol) for cleaning is prohibited.

CAUTION

Avoid getting petroleum products on rubber parts, since these products can cause deterioration of rubber.

Painted Surfaces. Use clean water or a solution of either 1/4 pound of soap chips or 6 ounces of painted-surface detergent to 1 gallon of hot water for cleaning painted surfaces. After cleaning, dry the surfaces thoroughly.

Electrical Parts. Use technical trichloroethane (methyl chloroform), Specification O-T-620, to clean electrical parts. Do not immerse or soak painted parts or plastics in trichloroethane. Do not use thrichloroethane to clean rubber parts other than neoprene.

Rubber Parts. Clean rubber parts with soap and warm water. Apply a coating of powdered technical talcum, Specification ZZ-T-416, to preserve rubber.

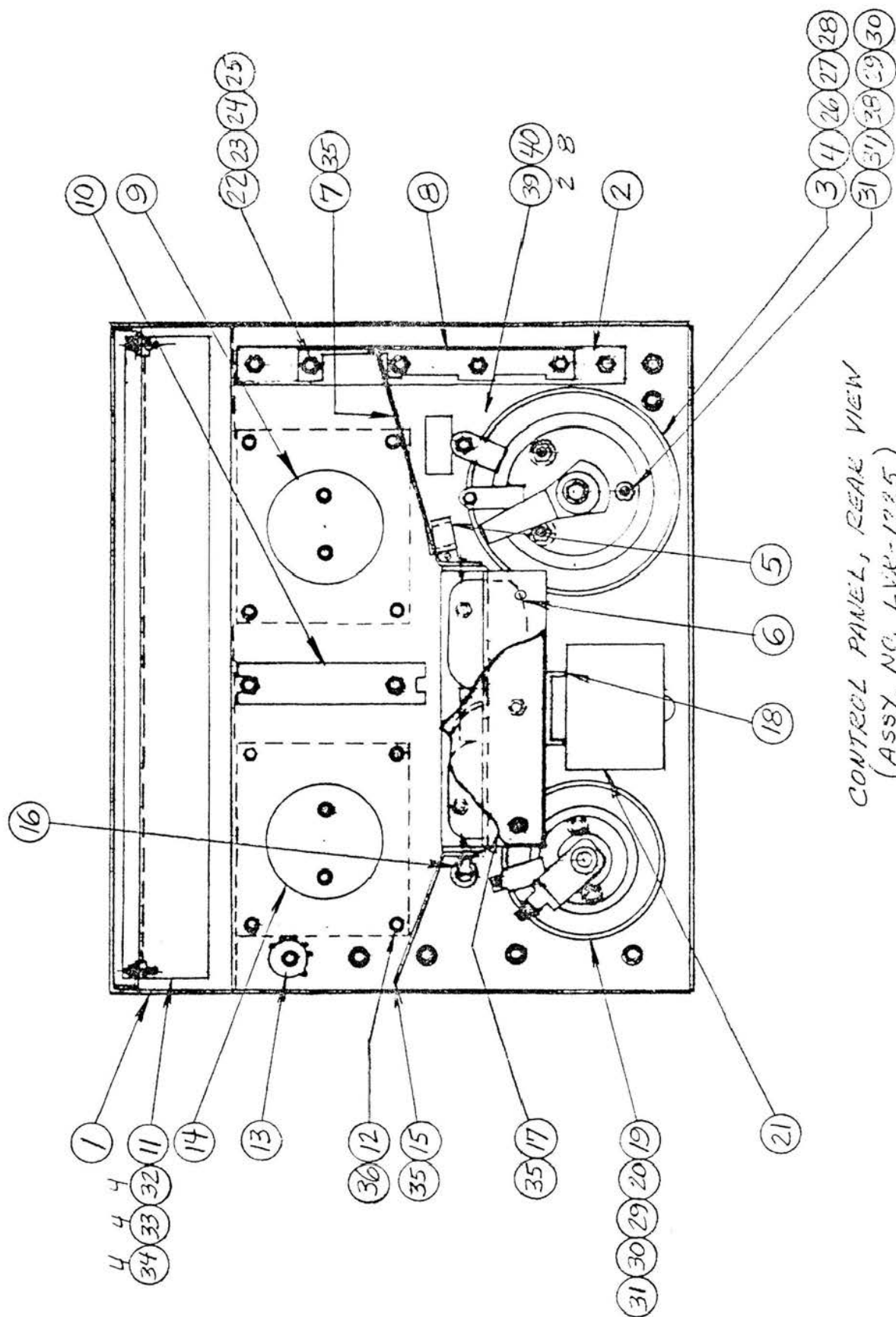
Meters. Clean the glass of each meter using a soft cloth dampened with a solution of common detergent and water. After cleaning, allow the glass to dry without rubbing. Then, apply antistatic compound, Specification, MIL-C-12156.

SECTION IX

PARTS LISTING

(ILLUSTRATIONS, DRAWINGS & PARTS IDENTIFICATION)

FIGURE 17	Control Panel, Rear View,	-	Assy. No. LVR-1225
FIGURE 18	Control Panel, Top View	-	Assy. No. LVR-1225
FIGURE 19	Load Resistor Panel	-	Assy. No. LVR-1250
FIGURE 20	Link Bar	-	Assy. No. LVR-1260
FIGURE 21	Electrical Schematic	-	DWG. No. LVR-5000
FIGURE 22	Wire Assembly Leads Listing		



CONTROL PANEL, REAR VIEW
(ASSY. NO. LVR-1225)

FIGURE 17

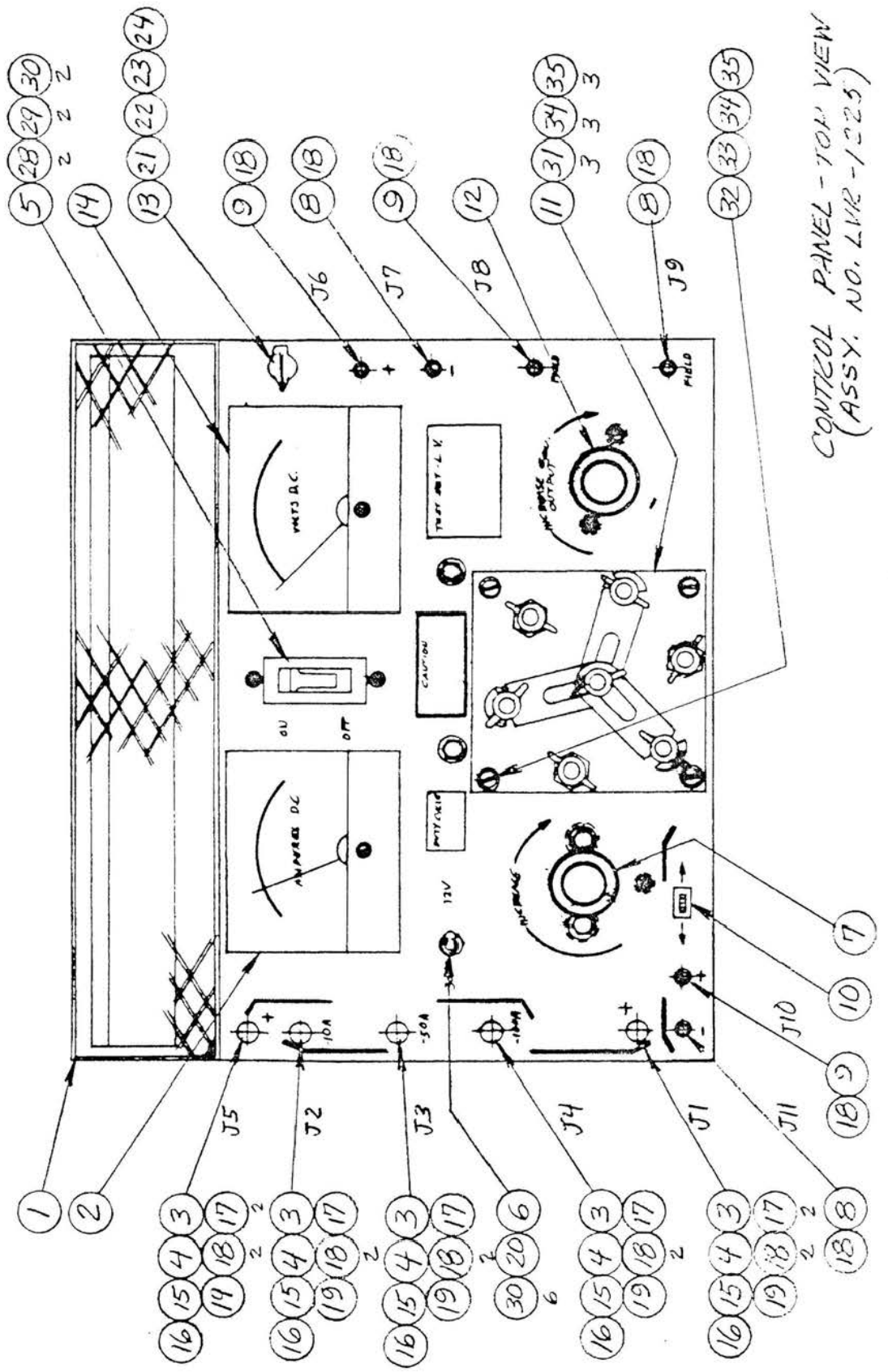
CONTROL PANEL, REAR VIEW (ASSY NO. LVR-1225)

FIGURE & INDEX NO.	SUN PART NO.	DESCRIPTION	REF SYMBOL	QTY PER TESTER
17 - 1	LVR-1200	Control Panel		1
- 2	LVR-1232	Insulator Strip		1
- 3	LVR-5008	Rheostat, Load	R6	1
- 4	LVR-1219	Spacer, Rheostat		2
- 5	718-314	Clamp, Loop		1
- 6	LVR-1238	Fan Blade, Axial		1
- 7	LVR-1242	Heat Shield - Load Side		1
- 8	LVR-1231	Shunt Assy		1
- 9	LVR-5003	Ammeter	M1	1
- 10	LVR-5002	Switch	S1	1
- 11	LVR-1250	Panel Assy, Load Resistors		1
- 12	LVR-1216	Grommet (Isolator)		8
- 13	LVR-5021	Switch & Resistor Assy	S7	1
- 14	LVR-5004	Voltmeter	M2	1
- 15	LVR-1243	Heat Shield - Field Side		1
- 16	LVR-5014	Resistor - 5 Ohms	R12	1
- 17	LVR-1241	Panel, Air Flow		1
- 18	LVR-1235	Assy, Fan Support		1
- 19	LVR-5009	Rheostat, Field	R13	1
- 20	LVR-1230-02	Spacer, Rheostat		2
- 21	LVR-1239	Motor, Fan	B1	1
- 22	675-66	Screw, Brass 1/4-20x5/8		1
- 23	LVR-1291	Nut, S.S.		1
- 24	LVR-1292	Flatwasher, S.S.		1
- 25	604-53	Lockwasher, 1/4 Bronze		1
- 26	675-83	Screw, 1/4-20x1-1/2		2
- 27	602-14	Lockwasher, 1/4 Int.		2
- 28	400-139	Flatwasher, Special		2
- 29	400-238	Flatwasher, #10		3
- 30	604-11	Lockwasher, #10		3
- 31	410-068	Screw, P.H. #10-32x1/2		3
- 32	675-033	Screw, 1/4-20x1/2 H.H.		4
- 33	400-089	Flatwasher, 1/4		4
- 34	604-14	Lockwasher, 1/4		4
- 35	610-71	Screw, #6 Sheet Metal		6
- 36	616-6	Keps Nut #6-32		8

FIGURE 17

CONTROL PANEL, REAR VIEW (ASSY NO. LVR-1225)

FIGURE & INDEX NO.	SUN PART NO.	DESCRIPTION	REF SYMBOL	QTY PER TESTER
17- 37	LVR-1306	Spacer	-	1
- 38	410-80	Screw, #10-32 X 1.0		1 MS35207-267
- 39		Ty-rap - 5-5/8 Long		2 Nortron #3811-0004-1
- 40	5878-0015	Ty-Rap - 4" Long		8

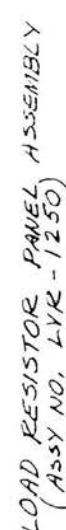


CONTROL PANEL - TOP VIEW
(ASSY. NO. LVR-1225)

FIGURE 18

CONTROL PANEL, TOP VIEW (ASSY NO. LVR-1225)

FIGURE & INDEX NO.	SUN PART NO.	DESCRIPTION	REF. SYMBOL	QTY PER TESTER
18- 1	LVR-1200	Control Panel		1/REF
- 2	LVR-5003	Ammeter	M1	1/REF
- 3	838-503	Binding Post Assy	J1,J2,J3 J4 & J5	5
- 4	LVR-1228	Flanged Bushing		5
- 5	LVR-5002	Switch	S1	1/REF
- 6	LVR-5005	Switch	S2	1
- 7	LVR-1234-02	Knob - Load Rheostat		1
- 8	LVR-1226-02	Jack - Black	J7,J9 & J11	3
- 9	LVR-1226-01	Jack - Red	J6,J8 & J10	3
- 10	LVR-5006	Switch, Slide	S6	1
- 11	LVR-1260	Link Bar Assy	S3,S4 & S5	1
- 12	LVR-1234-01	Knob Field Rheostat		1
- 13	LVR-5021	Switch & Resistor Assy	S7	1
- 14	LVR-5004	Voltmeter	M2	1/REF
- 15	2179-2	Terminal Stud		5
- 16	602-14	Lockwasher, 1/4 Int.		5
- 17	LVR-1292	Flatwasher, S.S.		7
- 18	604-53	Lockwasher, 1/4" Bronze		16
- 19	LVR-1291	Nut, S.S.		5
- 20	602-21	Lockwasher - Special		1
- 21	LVR-1233	Knob		1
- 22	602-35	Lockwasher - 3/8		1
- 23	409-20	Nut, 3/8-32 Thds.		1
- 24	400-4	Flatwasher - 3/8		1
- 25	675-174	Screw - 1/4-20x5/8		3
- 26	400-089	Flatwasher - 1/4		3
- 27	604-14	Lockwasher - 1/4		3
- 28	406-005	Screw B.II. #6-32x1/4 Lg.		2
- 29	400-261	Flatwasher #6		2
- 30	604-006	Lockwasher #6		8
- 31	410-059	Screw #10-32x1-1/4		3
- 32	410-83	Screw #10-32x1-1/2		1
- 33	409-17	Nut #10-32		1
- 34	400-036	Flatwasher, #10		4
- 35	604-11	Lockwasher, #10		4



34

LOAD RESISTOR PANEL ASSY. (ASSY NO. LVR-1250)

FIGURE & INDEX NO.	SUN PART NO.	DESCRIPTION	REF SYMBOL	QTY PER TESTER
19-1	LVR-1251	Panel, Resistor		1
-				
-3	616-4	Nut, #8-32, Keps		9
-				
-5	LVR-1305	Bushing, Insulating		9
-6	408-83	Screw, #8-32 X 2"		9 MS35206-253
-7	LVR-1259	Bar, Jumper		2
-8	LVR-1290-02	Screw, SS - 5/8" Lg.		7 1/4-20, 7/16 Hex. X 5/32 #18-8 Alloy
-9	LVR-1304	Isolator/Snubber		18
-10	LVR-1254	Bus Bar		1
-11	LVR-5001-5	Lead Assy		1/REF.
-12	LVR-1257-9	Resistor	R10	1 0.46 OIMS
-13	LVR-1257-10	Resistor	R11	1 0.46 OIMS
-14	LVR-1257-3	Resistor	R3	1 1.11 OIMS
-15	LVR-1257-5	Resistor	R5	1 1.16 OIMS
-16	LVR-1257-4	Resistor	R4	1 1.16 OIMS
-17	LVR-1257-6	Resistor	R7	1 0.69 OIMS
-18	LVR-1257-7	Resistor	R8	1 0.82 OIMS
-19	LVR-1257-8	Resistor	R9	1 0.44 OIMS
-20	LVR-1257-1	Resistor	R1	1 1.73 OIMS
-21	LVR-1257-2	Resistor	R2	1 2.05 OIMS
-22	LVR-1292	Flatwasher, S.S.		49 9/32X5/8X.050 #18-8 Alloy
-23	LVR-1293	Spacer, Insulator		13
-24	LVR-1294	Shoulder Bushing		13
-25	LVR-1291	Nut		33
-26	LVR-1290-01	Screw, S.S. 1-1/2 Lg.		13 1/4-20, 7/16 Hex X 5/32, #18-8 Alloy
-27	604-53	Lockwasher, Bronze		33 MS35338-101

FIGURE 19

LINK BAR ASSEMBLY (ASSY. NO. LVR-1260)

FIGURE &
INDEX NO.

FIGURE & INDEX NO.	SUN PART NO.	DESCRIPTION	REF SYMBOL	QTY TESTER
20 - 1	LVR-1261	Board, Screened		1
- 2	LVR-1263	Link, Shorting		3
- 3	LVR-1283-03	Stud, 1/2 inch High		2
- 4	LVR-1283-02	Stud, 3/8 inch High		2
- 5	LVR-1283-01	Stud, 1/4 inch High		3
- 6	LVR-1269	Roll Pin, Stain. Steel		3
- 7	407-23	Wing Nut, Plated		7
- 8	400-165	Flatwasher, Brass		8
- 9	604-18	Lockwasher, Bronze		7
- 10	LVR-1284	Nut, Brass Jamb		7
- 11	LVR-1265	Spacer, Link Board		4

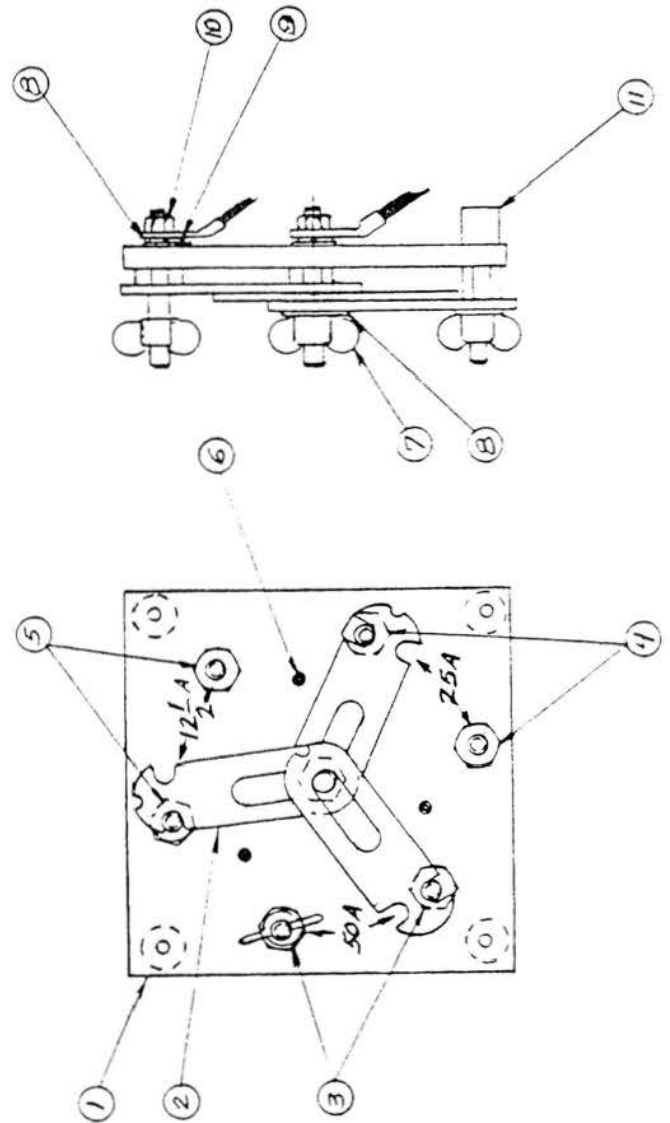
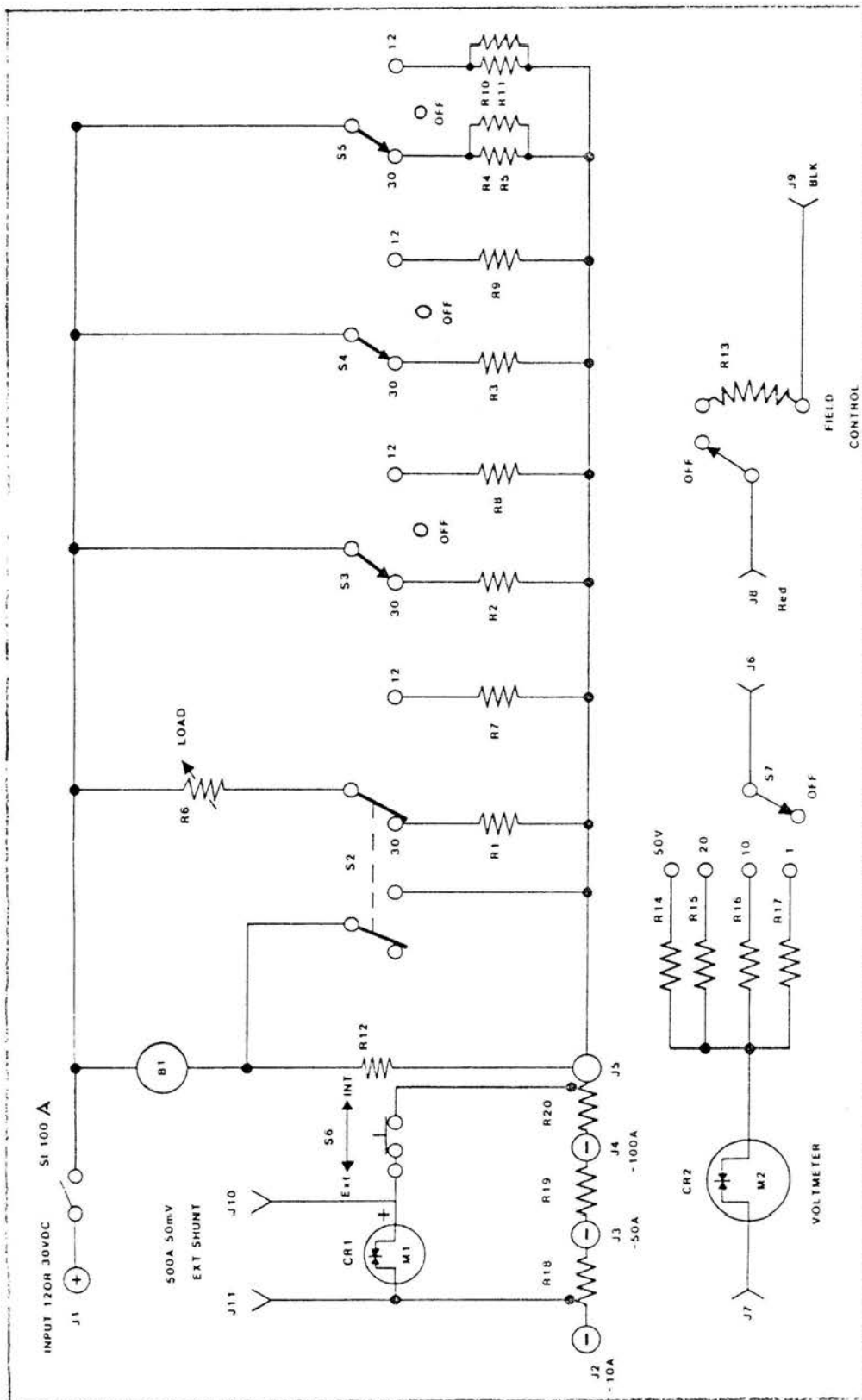


FIGURE 20



1	LVR-1239	MOTOR, 12VDC, FAN	R1	1	LVR-5010	RESISTOR, 49.9K.	R14	1	LVR-5010	RESISTOR, 49.9K.
2	771-240	METER PROTECTOR	R2	1	LVR-5011	RESISTOR, 20K.	R15	1	LVR-5011	RESISTOR, 20K.
5	82B-503	BRIDGING POST, 100A	R3	1	LVR-5012	RESISTOR, 10K.	R16	1	LVR-5012	RESISTOR, 10K.
3	LVR-1226-01	BRIDGING POST, RED, 10A	R4	1	LVR-5013	RESISTOR, 953.	R17	1	LVR-5013	RESISTOR, 953.
3	LVR-1226-02	BRIDGING POST, BLK, 10A	R5	1	LVR-1231	SHUNT ASSY, 50mV	R18	1	LVR-1231	SHUNT ASSY, 50mV
1	LVR-5003	ANALOG METER	R6	1						
1	LVR-5004	VOLTMETER	R7	1						
1	LVR-5002	SWITCH, 100A	R8	1						
1	LVR-5005	TOGGLE SWITCH, 5PDT	R9	1						
1	LVR-1260	LINK BAR ASSY, 3PDT	R10	1						
1	LVR-5006	SWITCH, 5PDT	R11	1						
1	LVR-5007	SWITCH, ROTARY, 5PDT	R12	1						
			R13	1						
			R14	1						

SCHEMATIC, ELECTRICAL
TEST SET, LOW VOLTAGE CIRCUIT

LVR-5000

FIGURE 21

WIRE ASSEMBLY LEADS LISTING

LEAD NO.	PART NO.	LENGTH (IN INCHES)	DESIGNATOR		REMARKS
			FROM	TO	
1A	LVR-5001-1	14-1/2	J1	S1	
2A	LVR-5001-2	11	S1	S3-4-5	
2B	LVR-5001-3	5-1/2	S1	R6-2	
2C	LVR-5001-4	-	B1	S1	Supplied with Fan Motor
3A	LVR-5001-5	2-1/2	J5	R10	
3B	LVR-5001-6	7-1/2	J5	R20	
3C	LVR-5001-7	14-1/2	R20	R12	
3D	LVR-5001-8	16	R12	S2-3	
4A	LVR-5001-9	16	R12	S2-2	
4B	LVR-5001-10	-	B1	R12	Supplied with Fan Motor
5A	LVR-5001-11	5	R20	S6	(LVR-1231-02)
6A	LVR-5001-13	11	M1+	S6	
6B	LVR-5001-14	11	M1+	J10	
7A	LVR-5001-12	5	R18	M1	(LVR-1231-01)
7B	LVR-5001-15	11	M1 (-)	J11	
8A	LVR-5001-16	4	S2-5	R6-3	
9A	LVR-5001-17	14	S2-6	R7	
10A	LVR-5001-18	14	S2-4	R1	
11A	LVR-5001-19	15-1/2	S3 (30V)	R2	
12A	LVR-5001-20	15-1/2	S3 (12V)	R8	
13A	LVR-5001-21	15-1/2	S4 (30V)	R3	
14A	LVR-5001-22	15-1/2	S4 (12V)	R9	
15A	LVR-5001-23	14-1/2	S5 (30V)	R4-R5	
16A	LVR-5001-24	14-1/2	S5 (12V)	R10-R11	
17A	LVR-5001-25	7	J7	M2 (-)	
18A	LVR-5001-26	-	S7	M2 +	Leads are part of Resistors
19A	LVR-5001-27	5	J6	S7 (Com.)	
20A	LVR-5001-28	7	J8	R13-3	
21A	LVR-5001-29	7	J9	R13-2	

FIG.22

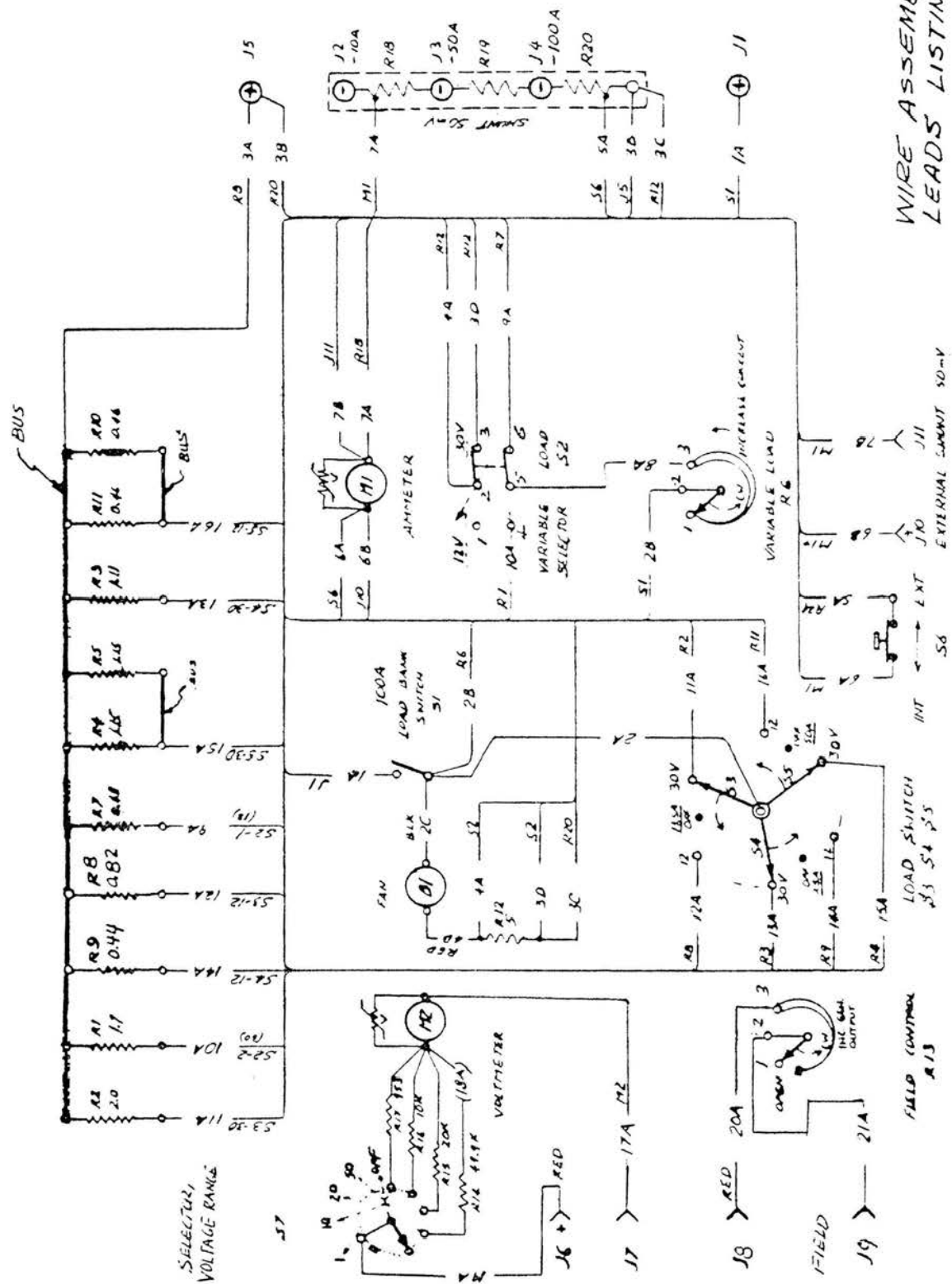


FIGURE 22